SHIPYARD OUTSIDE MACHINIST

Instructor's Guide

PART I

Outside Machinist Training for Beginners

PART II

Outside Machinist Training:
Advanced Work and Maintenance

PART III

Outside Machinist Training:
Installations, Maintenance, and Repairs

BULLETIN 345-L

Commonwealth of Pennsylvania
DEPARTMENT OF PUBLIC INSTRUCTION
Harrisburg
1943

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Vocational Training
for
War Production Workers

SHIPYARD OUTSIDE MACHINIST

Instructor's Guide

(Suggested instructional aids with special references to Bulletin 345-K, "Shipyard Outside Machinist," published by the Commonwealth of Pennsylvania, Department of Public Instruction).

Bulletin 345-L

Prepared by the

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CHESTER, PENNSYLVANIA

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FOREWORD

This instructor's guide contains suggested outlines and procedures which may be helpful to instructors using Bulletin 345-K, "Shipyard Outside Machinist".* Instructors of shipyard outside machinists will find the guide to be a useful aid, although Bulletin 345-K may not be available to trainees.

The cooperation and assistance of the Sun Shipbuilding and Dry Dock Company, Chester, Pennsylvania, is acknowledged. Special acknowledgment is extended to E. G. Lamberson, Superintendent of No. 4 Yard; to George Ebaugh, General Foreman of Installation Machinists; to William Evans, Foreman of Installation Machinists; to Patrick Daly, Foreman of Installation Machinists; and to George Randall, Leader of Installation Machinists, for their cooperation and criticism of final copy. Acknowledgment is extended to Outside Machinist leading men for their assistance in the preparation of text material, sketches, and photographs.

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FRANCIS B. HAAS
Superintendent of Public Instruction

February, 1943

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GENERAL NOTES CONCERNING THE MANUAL "SHIPYARD OUTSIDE MACHINIST"

Application of the Manual

The manual, *Shipyard Outside Machinist*, may be applied to the training of beginning workers, advanced workers, and maintenance and repair outside machinists. It is designed principally for the guidance of shipyard outside machinists, that is, machinists who work around the wet basins and on the ways. A number of the processes and operations presented are also applicable to many of the shop machinist's training problems. It should be noted that this outline is specifically intended for instruction of shipyard "outside" machinists.

Outline of Instruction

Page vi of this *Instructor's Guide* shows in outline form the content and sequence of instructional units which are contained in the manual *Shipyard Outside Machinist*. These are, in part, an outline of instruction for the outside machinist.

Distinction Between Parts I, II, and III

Part I stresses general safety practice; it acquaints the trainee with various locations of storerooms and stock piles which are of vital importance to his working efficiency. This section gives the beginner and the advanced trainee a general idea of the tools and equipment he will be expected to use while performing his work.

"General Arrangement of a Ship" acquaints the beginner with the specific locations where certain jobs are to be done and where installations must be made.

The remainder of Part I introduces to the trainee the names and uses of various tools and pieces of equipment, and indicates typical examples of correct applications of tools for the beginner.

Part II contains typical examples of work for advanced trainees. Some maintenance and repair work is included in overhauling and grinding valves and in overhauling a pump and packing stuffing boxes. Particular attention has been given to representative jobs which will prepare the trainee for general work.

Part III is arranged for the training of the more skillful mechanics who have shown initiative and who have demonstrated their ability to handle the more complicated types of work. Specific training may be given the trainee by making certain selections and sequences of presentation. For example, one group may be trained to fit blocks and align pump and motor units. Another group may be trained to run straight line and bore, with a boring bar, the stern-frame eye and bulkheads.

Use of Sketches and Photographs

Text material in the manual, *Shipyard Outside Machinist*, is arranged so as t require trainees to read blueprints sufficiently well to identify units and determin correct locations for installations aboard ship. Pictorial drawings and photograph are included to indicate more clearly the meaning of the blueprint as related to th objective or unit to be installed.

Blueprint Reading and Terminology

A course in blueprint reading for shipyard outside machinists should be availabl since the trainees must be able to make layouts of the work. To interpret blueprint correctly, the trainee must have the following qualifications:

(a) Knowledge of alphabet of lines used on blueprints.

(b) The ability to interpret correctly the relationship of the several views the job.

(c) The ability to recognize dimension locations on the blueprint and to lay o correctly a corresponding line on center location on the work.

(d) The ability to read a cross section of the view and correlate it with the oth views given on a blueprint.

Some typical examples of the fundamentals of blueprint reading are given in t appendix of *Shipyard Outside Machinist* manual. The trainee should have had so preliminary instruction in blueprint reading to make satisfactory progress. Bullet 345-B. *Blueprint Reading for Shipfitters*, published by the Commonwealth of Pen sylvania (1942), is a workbook for beginning and advanced training for shipya workers. This Bulletin presents fundamentals of blueprint reading and includ twenty-five detailed blueprints of portions of ship structures which frequently occ in shipyard work. This Bulletin is recommended for use as a course in bluepri reading for shipyard outside machinists.

Essential terminology is presented at the time when the work outline requires t knowledge of such terms. A separate compilation of terms and definitions of val in instructing outside machinists appears in an appendix. Abbreviations used outside machinists and welding terms with which outside machinists must be famil are also included in the appendix.

PART I

TRAINING FOR BEGINNING OUTSIDE MACHINISTS

Part I

OUTSIDE MACHINIST TRAINING FOR BEGINNERS

Instructional Materials and Teaching Devices

Where classes for beginners are conducted in close cooperation with shipyards it probable that much instructional material may be brought into the school, shop, classroom. Motion pictures will be helpful, especially so when visits to shipyards an not be arranged.

The use of mock-ups, models, blueprints, sketches, and photographs will further dd to the effectiveness of training for beginners. The use of practical work jobs hich can be simulated in the school shop is essential, much of the effectiveness of aining for beginners being dependent upon the resourcefulness of the instructor providing these experience opportunities.

Objectives of Training for Beginning Shipyard Outside Machinists

To shorten the usual breaking-in period.

To develop basic skills in the use of tools and in handling materials.

To develop a knowledge of locations, terms, shapes, procedures, etc., pertaining to outside machinist practice.

To lay groundwork which will help the trainee to advance more rapidly in skill and knowledge as a result of his practical work experience in the shipyard.

SUGGESTED MINIMUM LIST OF TOOLS, EQUIPMENT, AND SUPPLIES FOR A BEGINNING COURSE IN SHIPYARD OUTSIDE MACHINIST

(Class of ten to fifteen trainees)

TOOLS

1. 5 — ball-peen hammers (2 lb.)
   10 — ball-peen hammers (1¼ lb.)
2. 10 — 6″ steel scales
3. 2 — 50′ steel tapes
4. 3 — 6′ steel tapes
5. 5 — 4″ to 6″ inside calipers
6. 5 — 4″ to 6″ outside calipers
7. 5 — 6″ hermaphrodites
8. 5 — prick punches
9. 5 — center punches
10. 2 — one-inch outside micrometers
11. 2 — two-inch outside micrometers
12. 1 — one-inch test gauge
13. 1 — inside micrometer
14. 5 — 4″ dividers
15. 5 — 6″ dividers
16. 5 — 8″ dividers
17. Assorted cold chisels
18. 5 — sets open-end wrenches
19. Large assortment of twist drills (straight and taper shank)
20. Large assortment of reamers
21. Hand-reamer wrenches (assorted)
22. 5 — combination squares
23. Dummy pedestals, chocks, and foundations
24. Short round bars with holes drilled for reaming to taper-pin sizes
25. Large assortment of taper pins
26. Short pieces of shafting to fit reamed holes
27. 12 — no. 4 taper hand reamers, spiral flutes
28. 12 — ½″ taper machine reamer, spiral flutes
29. 12 — twist drills for no. 4 taper pin
30. C-clamps, assorted sizes
31. 12 — 23/32″ twist drills
32. 10 — ½″ twist drills
33. 10 — 15/16″ twist drills.
34. 5 — 1″ spiral-flute reamer
35. 5 — 1″ straight-flute reamer
36. 5 — sets American Standard taps ½″
37. 5 — sets American Standard taps ⅝″
38. 5 — sets American Standard dies ½″
39. 5 — sets American Standard dies ⅝″
40. Quantity of twist drills to suit taps
41. 12 — 10″ half-round bastard files
42. Tap wrenches
43. Die stocks
44. Several stud drivers to suit studs
45. 5 — 12″ Stillson wrenches
46. Assorted sizes easy-outs
47. 5 — 12″ hack-saw frames
48. 4 doz. 12″ hack-saw blades, medium
49. 15 pairs, approved type of goggles
50. 5 screw pitch gauges, N. C.
51. 12 — 10″ flat bastard files
52. Screwdrivers, several assorted sizes
53. One dozen scribers
54. 5 each, ⅜″ and ⅝″ key drifts
55. 4 pairs 14″ tin snips
56. 4 — 24″ spirit levels
57. 5 — plumb bob and line
58. 5 — thickness gauges, 1.5 to 15 th
    andths
59. Several adjustable wrenches, assorted s
60. 4 — 12″ or 14″ monkey wrenches
61. 6 pairs side-cutting pliers, 8″ size
62. Assorted sizes 12-point box wrenches
63. Assortment of calking tools
64. Assortment of fox wedges
65. 12 — one-hundred-foot chalk lines
66. 6 each, flat and bull-nose scrapers
    suitable size for practice
67. 6 each, 3-corner and straight scraper
    a suitable size for the job
68. Assortment of packing hooks
69. Several drift punches of assorted siz
70. 3 oilstones, carborundum, fine and c
    combination
71. Hexagon socket wrenches
    (various sizes as needed)
72. 2 sets conventional socket wrenches
    ratchet handle
73. Several hexagon box wrenches
74. 5 — sets trammels with 24″, 48″, an
    beams
75. Several Allen wrenches for ¼″, ⅜′
    ½″ Allen set screws
76. 1 — four-foot, cast-iron straightedge

EQUIPMENT

1. Wall scale with slides
2. Benches and 5″ vises (ten at least)
3. Several pieces of pipe to fit over wrench for extra leverage
4. Air or electric drilling machine
5. Taper sleeves for drilling-machine chuck
6. Cutting oil and several oil cans
7. Broken or damaged drills
8. Corner drilling machine
9. Drilling post

SUPPLIES

1 Scratch paper
2 Machined parts to be measured with a scale
3 Assorted sizes of round and square metal stock
4 Stock with bored, reamed, and drilled holes to be measured with calipers
5 Sheet-metal stock for layout purposes
6 Layout solution
7 Chalk
8 Several pieces round stock (precision ground) for practice measuring with micrometers
9 Several pieces of different sizes of piano wire or drill rod. 8″ to 12″ long
0 Several pieces of plate, precision ground to thickness or width
1 Several pieces of steel plate ⅛″ to ¾″ thick, and 10″ to 12″ long
2 Blueprints or mimeographed sheets showing several holes to be laid out
3 Cast-iron blocks or strips ½″ x 3″ x 12″ and 1″ x 3″ x 12″
4 Several bored journals, 4″ diam.
5 Assortment of square and hexagon nuts
6 Flat bar drilled to accommodate various diameters of bolts. (Several pieces of various sizes)
7 Quantity of various sizes of studs
8 Several pieces of stock with drilled holes to be reamed later
9 4 taper pins (4 dozen)
0 Iron or steel couplings bored 23/32″ inside diameter
1 Steel plates drilled 23/32″ (quantity)
2 Steel plates drilled 15/32″ (quantity)
3 Brass couplings bored 23/32″ diameter (quantity)
4 Several ¾″ C.R. rods
5 ½″ steel plates with 7/16″ drilled holes along the plate edges. Plates to be tack-welded together in pairs with the rows of holes almost lines over each other for practice reaming
26. Quantity of ½″ bolts, 1½″ long (with nuts)
27. Several wood blocks cut half-round to hold couplings and rods in a vise
28. Bushings for ¾″ hole bored ⅜″ I.D.
29. Four dozen ¾″ fitted bolts, .7505″ O.D. (length optional)
30. Four dozen black bolts (length optional)
31. ¾″ steel plates 18″ x 36″ (one dozen)
32. ½″ bushings to fit 15/16″ holes
33. Four dozen 1.00025″ fitted bolts (optional length)
34. Four dozen 1″ black bolts (optional length)
35. 3″ x 4″ chocks (quantity)
36. Flat steel-plate scrap for practice tapping
37. Quantity of round stock to suit dies
38. Quantity of bolts to be re-threaded
39. Quantity of nuts to suit taps
40. White lead
41. Several steel or iron pieces with topped holes of the stud to be used
42. Iron or steel plates containing several broken-off studs
43. Wood blocks into which screws may be driven for practice
44. Several steel plates tapped for various sizes of machine screws
45. Large assortment of 12″ square, 12″ mill, and 12″ flat bastard files
46. Large quantity of boiler plate, 1½″ wide x ⅜″ thick
47. Several each of round and square brass bars, 1″ x 1″ x 12″
48. Quantity of cast-iron bars, 1″ x 2″ x 12″, with one of the 2″ edges machined
49. Quantity of plain and gib-head keys
50. White lead
51. Quantity of shafting and couplings for key-fitting practice
52. Quantity of Allen set screws ¼″, ⅜″, and ½″

SUGGESTED OUTLINE OF MINIMUM ESSENTIALS FOR TRAINING BEGINNERS IN OUTSIDE MACHINIST WORK

Time required: Approximately 365 to 503 hours of instruction, including sh talks, demonstrations, and shop practice (practical work by trainee).

1. Safety practices in the shipyard.
2. Location of various shops, tool cribs, and storerooms.
3. Care and use of tools and equipment owned by the trainee.
4. Care and use of tools and equipment owned by the company.
5. General arrangement of a ship.

* 6. How to read and use a mechanic's scale.

* 7. How to use calipers, dividers, and morphs.

* 8. How to read and use the micrometer.

* 9. Correct use of machinist's hammer and center punch.

*10. Types and uses of cold chisels.

*11. How to select and use open-end wrenches.

*12. How to select and use twist drills and perform drilling operations.

*13. How to select and use reamers and perform reaming operations.

*14. How to proceed when reaming "through" holes.

*15. Care and use of a portable air drill.

*16. How to thread bolts and nuts and tap holes.

*17. How to tighten a stud in a threaded hole.

*18. How to remove studs or broken bolts.

*19. How to use and care for a screwdriver.

*20. How to select and use various types of files.

*21. How to fit a key.

22. The care and use of other outside machinist tools listed in Part I.

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* Shop Practice (manipulative).

Construction of This Outline

The outline herein contained was developed specifically to provide functional, necessary, and adequate instruction for beginning shipyard outside machinist trainee. It is not expected that a trainee who has completed a beginner's course will find employment as an experienced outside machinist. The trainee will likely be able to qualify as an outside machinist's helper upon completing the work required during the training period. The proper presentation and completion of the information and shop practice outlined in the guide should qualify the trainee to work efficiently as a helper to an outside machinist.

There are skills and information which a trainee will at first not need in his work and which he will not have time to acquire in a short course of study. Such skills and information are not considered as essential content in this outline.

Two types of subject matter for the instruction of beginners and advanced workmen are included in this suggested outline:

(a) Informational topics;

(b) Shop practices which involve the manipulation of tools and materials.

Both types of experiences are necessary for a well-rounded course of study.

TOPIC NO. 1

I. Topic — Safety.

II. Tools and Equipment
None

Supplies
None

III. Reference — *Shipyard Outside Machinist,* page 3.
Instructional Aids:
A. Charts showing accident frequency.
B. Company reports on loss of time and wages due to avoidable accident
C. Safety placards and bulletins.
D. Motion-picture visual aids.

Title	*Time in Minutes*	*Sound or Silent*	*Free or Charge*	*Company*
1. Speaking of Safety	10	Silent	Free	Films of Commerc
2. Approved by the Underwriters	40	Sound	Free	Underwriters Lab.
3. Twelve Points of Safety	20	Silent	Free	U. S. B. M.
4. Take it Easy	36	Si. or So.	Free	Y. M. C. A.
5. A Chance to Lose	12	Sound	Free	Dodge
6. A Safe Day	10	Sound	Free	Chevrolet
7. The Truck and the Driver	10	Sound	Free	Aetna Life

IV. Teaching Hints:
A. Information to be presented:
1. Physical requirements for specific jobs.
2. Hints on preservation of good general health.
3. Ordinary hazards that are frequently overlooked by the beginner.
4. Injuries that are frequently inflicted on the worker, and injuries w
are caused by his own carelessness.
5. Injuries which are caused by failure to respect the rights of others.
6. A sound basis for safe working relations with a view to:
a. Protecting one's self.
b. Protecting others.
c. Guarding company equipment and materials.
B. Suggested procedure:
1. Invite trainees to discuss personal safety problems.
2. Ask certain individuals to outline safe working procedure for sm
specific job.
3. Call for someone to give the history of some specific instance wher a
accident could have been avoided.

V. Assignment:
Provide true-false test of correct safety practice.

VI. Time — 3 to 5 hours.

TOPIC NO. 2

TOPIC — Location of Shops.

TOOLS AND EQUIPMENT	SUPPLIES
None	None

REFERENCE — *Shipyard Outside Machinist,* page 6.

INSTRUCTIONAL AID: Blueprint showing the layout of the shipyard for which training is given.

TEACHING HINTS:

A. Information to be presented:

1. Toolrooms in the yard.
2. General storerooms in the yard.
3. Numbers of ways in the yard.
4. Location of various yards.
5. Location of piers and wet basins.
6. Location of:
   a. Dispensaries (First Aid)
   b. Stretchers, gas masks, fire extinguishers, manifolds
   c. Bolt shed
   d. Tool cribs

B. Suggested procedure:

1. Have trainees refer to a layout of the shipyard. Discuss the location of units and the relationship existing between the various departments and the outside machinist.
2. Have trainees make a rough sketch and note locations in the yard for which training is being given.
3. Discuss the shortest way from the job to a certain storeroom, toolroom, or material shed. Point out how time may be saved by planning to avoid unnecessary trips for tools and materials.

ASSIGNMENT:

1. Divide the class into groups of three or four. Have each group assume responsibility for obtaining a quantity of material or certain tools from the proper source. Ask for a written report of the recommendations of the groups. Discuss the reports.

TIME — 3 to 4 hours.

TOPIC NO. 3

I. Topic — Personal Tools and Equipment; Their Uses and Care.

A. Essential personal tools which the beginning trainee should own.

B. Tools which the trainee should acquire early.

C. Tools which the outside machinist should eventually own.

II. Tools and Equipment	Supplies
Have some tools in class if possible	None

III. Reference — *Shipyard Outside Machinist,* page 7.

Instructional Aids: Tool Catalogs (if available):

1. Brown and Sharpe Mfg. Co., Providence, R. I.
2. Lufkin Rule Co., Saginaw, Mich.
3. Stanley Rule and Level Co., New Britain, Conn.
4. L. S. Starrett Co., Athol, Mass.

IV. Teaching Hints:

A. Safety:

Safe use of tools (when to wear goggles).

B. Information to be presented:

1. Proper name of each tool.
2. Care of each tool.
3. Use of each tool.
4. Low cost of tools compared with their useful life when properly use
5. How trainees may help in caring for tools.
6. The advantages and disadvantages of borrowing tools.
7. How a mechanic should guard his tools against loss and damage

C. Demonstration by the instructor:

As far as classroom surroundings permit, show how tools should be
to achieve the greatest efficiency.

V. Assignment:

A. Divide the class into small groups. Ask for a written report on the use
care of certain tools.
(The instructor selects the tools on which the groups are to make rep

B. Discuss the reports. Call for constructive criticism.

VI. Time — 2 hours.

TOPIC NO. 4

'OPIC — Company-owned Tools and Equipment; Their Uses and Care.

'OOLS AND EQUIPMENT
Have some in class if possible.

SUPPLIES
None

EFERENCE — *Shipyard Outside Machinist,* page 8.

NSTRUCTIONAL AIDS:
1. Equipment catalogs or pamphlets (if available)
2. Wall charts (if available)
3. Stanley Rule and Level Co., New Britain, Conn.
4. L. S. Starrett Co., Athol, Mass.
5. Lufkin Rule Co., Saginaw, Mich.
6. Brown and Sharpe Mfg. Co., Providence, R. I.

EACHING HINTS:

. Safety: Special handling of heavy tools and equipment.

. Information to be presented:

1. Proper name of each tool or piece of equipment. (Shop "nickname")
2. Correct use of tools and equipment.
3. Care of each tool.
4. Reasons for reporting damage or loss promptly.
5. What to do with tools and equipment when in need of repair.
6. Responsibility for the care, use, and return of tools.
7. Persons who authorize the requisitioning of company-owned tools.

SSIGNMENT:

ivide the class into groups. (Hand each group a written outline of one or ore simple jobs to be done.) Ask each group to list the tools and equipment hich will probably be required to do each job. Have someone in each group t as leader.

IME — 1 to 2 hours.

TOPIC NO. 5

I. Topic — General Arrangement of a Ship.

II. Tools and Equipment

None

Supplies

None

III. Reference — *Shipyard Outside Machinist*, page 9.

Instructional Aids:

1. Wall chart of three views of a ship. (An enlargement of page 11 in *Shipyard Outside Machinist* manual)
2. L. S. Starrett Co., Athol, Mass.
3. Lufkin Rule Co., Saginaw, Mich.
4. Brown and Sharpe Mfg. Co., Providence, R. I.
5. Stanley Rule and Level Co., New Britain, Conn.

IV. Teaching Hints:

A. Point out the necessity for a mechanic to know his way around aboard in order to save time and avoid making mistakes.

B. Information to be presented:

1. The general construction of a ship, beginning with the keel.
2. The duties of an outside machinist in relation to the building of a
3. The locations where the outside machinist will find his work.
4. Specific work locations on the wall chart.

V. Assignment:

A. Outline a specific installation to be made aboard ship. (Have genera lines prepared.) Distribute the outlines among the members of the

B. Present each trainee with a list of questions concerning practical wo procedures connected with the installation outlines.

VI. Time — 6 to 9 hours.

TOPIC NO. 6

TOPIC — Proper Use and Care of Mechanic's Scale.

TOOLS AND EQUIPMENT

1. 6″ steel scale (No. 4 graduations)
2. 6′ steel tape
3. 50′ steel tape
4. Wall scale with slides. See Figure 1 below.

SUPPLIES

Scratch paper
Several objects to be measured

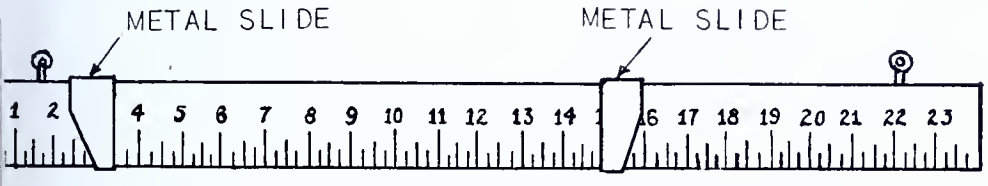


FIG. 1 — *Metal Slides are Adjustable on Scale.*

REFERENCE — *Shipyard Outside Machinist,* page 12.

INSTRUCTIONAL AIDS: Tool Catalogs (if available):

1. L. S. Starrett Co., Athol, Mass.
2. Lufkin Rule Co., Saginaw, Mich.
3. Brown and Sharpe Mfg. Co., Providence, R. I.
4. Stanley Rule and Level Co., New Britain, Conn.

TEACHING HINTS:

1. Information to be presented:
   1. Types of scales and their uses.
   2. Meaning of the term "Standard".
   3. Correct care of scales.
   4. Various ways and methods of measuring with a scale.
   5. Accurate scale reading.

2. Demonstration by the instructor:
   1. How to hold a scale (various conditions).
   2. How to measure most efficiently with a scale.
   3. How to measure with a steel tape and use it correctly.
   4. How to add and subtract dimensions with the use of the scale.

C. Student practice:

1. With the help of the wall scale, drill the trainees in reading various sc settings.
2. Have the trainees add several fractions, using the scale only.
3. Refer to page 19 of the *Shipyard Outside Machinist* manual and have trainees note the answers to the problems. Use a separate sheet of pa
4. Refer to page 20 of the manual and have the trainees note the answ to the problems. Use a separate sheet of paper.

   Mimeographed copies of pages 19 and 20 may be used instead separate sheets of paper. The papers may then be collected and corre by the instructor. Grades based on 100% may be given.
5. Have trainees measure distances that have been laid off on the floo wall. Have the measurements checked by other trainees.

D. Suggested procedure:

1. Trainees work individually when measuring with a scale.
2. Trainees work in pairs when measuring with a steel tape.
3. Members of the group may criticize.
4. The instructor will criticize.

V. Assignment:

Items "3" and "4" under student practice may be used here.

VI. Time — 6 to 9 hours.

TOPIC NO. 7

TOPIC — Use and Care of Calipers, Dividers, and Hermaphrodites (Morphs).

TOOLS AND EQUIPMENT

1. Inside and outside calipers (4″ to 6″)
2. Hermaphrodites (6-inch)
3. Steel scale
4. Dividers (4-inch)
5. Prick punch
6. Light hammer

SUPPLIES

Assorted sizes of round and square metal stock.

Machined metal stock with bored, reamed, or drilled holes, from ¾″ diameter up to 3″ diameter.

Sheet-metal stock 12″ x 18″. (Aluminum, zinc, or galvanized.)

Layout solution (Aniline and shellac or pigment-colored shellac.)

Chalk.

REFERENCE — *Shipyard Outside Machinist*, page 23.

INSTRUCTIONAL AIDS: Wall charts of tools (if available):

1. L. S. Starrett Co., Athol, Mass.
2. Lufkin Rule Co., Saginaw, Mich.
3. Brown and Sharpe Mfg. Co., Providence, R. I.
4. Stanley Rule and Level Co., New Britain, Conn.

TEACHING HINTS:

A. Information to be presented:

1. Various types of calipers, dividers, and hermaphrodites.
2. Correct type of tool to use for various jobs.
3. Care of these types of tools.
4. Shop kinks in adapting these tools to measuring problems.

B. Demonstration by the instructor:

1. The measuring of various pieces of work correctly. (Show how to hold the tools.)
2. The measuring of a diameter or thickness and laying out the shape on a layout sheet.

3. How to color shellac.
4. The application of shellac to a sheet-metal surface.
5. The application of chalk to a sheet-metal surface.
6. The use of a hammer and prick punch to locate centers.
7. The method of laying off two lines at right angles to each other with the use of a square.

C. Student practice:

1. Distribute metal layout sheets to trainees, and have them prepare sur of metal sheet for layout.
2. Make a blackboard layout, and have trainees copy by laying out blackboard figure on the sheet metal.
3. Have trainees lay out several given sizes of circles. (Check for accura
4. Have trainees lay off lines parallel to edges using the hermaphrodite

V. Assignment:

Distribute prepared sheets to trainees (all different) and have them make outs on sheet metal. Use only the tools mentioned under II. "Topic No. 7" p

VI. Time — 6 to 9 hours.

TOPIC NO. 8

Topic — Reading the Micrometer.

Tools and Equipment

1. One-inch and two-inch outside micrometers
2. One-inch test gauge (1.000 dia.)
3. Inside micrometer
4. 6″ scale

Supplies

Several pieces round stock, precision ground

Several pieces with precision-ground holes

Several pieces of plate precision-ground to thickness or width

Several pieces of different-sized piano wire or drill rod.

Reference — *Shipyard Outside Machinist*, page 28.

Instructional Aids:

1. Wall chart of micrometer. (See tool companies listed below.)
2. Tool catalogs (if available):
   a. L. S. Starrett Co., Athol, Mass.
   b. Lufkin Rule Co., Saginaw, Mich.
   c. Brown and Sharpe Mfg. Co., Providence, R. I.
   d. Stanley Rule and Level Co., New Britain, Conn.

Teaching Hints:

A. Information to be presented:
   1. Types of micrometers
   2. Care of micrometers
   3. Capacity of micrometers
   4. Reasons for using micrometers
   5. How to read micrometers
   6. Recording micrometer readings (decimals)

B. Demonstration by the instructor:
   1. The correct way to hold micrometers.
   2. Getting the "feel" of micrometers.
   3. Scale reading compared with micrometer reading.

4. The measuring of several pieces of work with outside micrometers the recording of the readings. Have the trainee go over the same w and record his readings. Compare the results.

5. Repeat the procedure in item 4 with inside micrometers.

6. Repeat the procedure in item 4 using the pieces precision-ground to v ous thicknesses.

C. Student practice:

1. Drill trainees in the methods of placing decimal points and calcula with decimals.

2. Compare decimal equivalent table with scale readings.

3. Rehearse items 1 and 2 with the use of prepared problems to be sol (Use blackboard.)

4. Have trainee set micrometers according to dimensions listed on the bl board.
(The instructor will inspect each setting individually and criticize.)

V. Assignment:

Have trainees note the readings of micrometer settings on page 33 of *Shipyard Outside Machinist* manual. A separate sheet of paper should be u

VI. Time — 9 to 12 hours.

TOPIC NO. 9

TOPIC — Machinist's Hammer and Center Punch.

TOOLS AND EQUIPMENT	SUPPLIES
1. 1¼-lb. machinist's hammer	Several pieces of steel plate
2. Prick punch	Chalk
3. Center punch	Simple blueprint or mimeographed sheets showing several holes to be laid out.
4. 6″ scale	
5. 4″ dividers	

REFERENCE — *Shipyard Outside Machinist*, page 36.

INSTRUCTIONAL AIDS:

1. Steel plates with holes laid out and center-punched
2. Tool catalogs (if available):
   a. L. S. Starrett Co., Athol, Mass.
   b. Lufkin Rule Co., Saginaw, Mich.
   c. Brown and Sharpe Mfg. Co., Providence, R. I.
   d. Stanley Rule and Level Co., New Britain, Conn.

TEACHING HINTS:

A. Information to be presented:

1. The purpose of center-punching.
2. The correct punch to use, prick punch or center punch.
3. The correct weight of hammer to use.
4. The correct way to hold a center punch:
   a. On a horizontal surface on the floor or bench.
   b. On a vertical surface.
   c. On an inclined surface.
   d. On an overhead surface.
5. Striking the blow (hard or soft).
6. "Drawing" a hole center over.
7. What to do with a "hard" or "soft" center punch or prick punch.
8. Danger involved in using a center punch with a head mushroomed by use. (Safety)

B. Demonstration by the instructor:

1. How to lay out centers, center-punch, scribe circles, and mark c cumferences.
2. How to locate a center with a prick punch and how to "draw" the cent
3. How to hold the hammer correctly.

C. Student practice:

1. Have the trainees practice holding the center punch and hammer a cxperiment with prick-punch and center-punch markings.
2. Have the trainees lay off several centers and scribe circles to repres the diameters of holes to be drilled. (Sketch on the blackboard the l out to be followed.)
3. Criticize the work.
4. Repcat until the trainee is sufficiently drilled.

V. Assignment:

Distribute blueprints or mimeographed sheets and have the trainees make l outs. (No two sheets should be the same.)

VI. Time — 3 to 6 hours.

TOPIC NO. 10

Topic — Types and Uses of Cold Chisels.

Tools and Equipment

1. Assorted cold chisels
2. 6″ morphs.
3. 6″ scale.
4. 1½-lb. machinist's hammer
5. Bench and bench vise.
6. 10″ bastard file
7. Hammer and prick punch.
8. Goggles.

Supplies

Several pieces of steel plates ⅛″ to ½″ thick, 4″ wide, and 8″ to 12″ long.

Chalk.

Several pieces of cast iron ½″ thick (scrap of various lengths not over 12 inches).

A few bored journals (4″ dia.)

Reference — *Shipyard Outside Machinist*, page 38.

Instructional Aids:

A. Wall chart (Stanley Rule and Level Co., New Britain, Conn.)

B. Some pieces of work that have been processed with a cold chisel.

Teaching Hints:

A. Safety:

How injuries are caused in the use of cold chisels, and how to prevent these injuries.

B. Information to be presented:

1. Types of cold chisels.
2. Jobs on which certain types of cold chisels are used.
3. How to prepare the cutting edge and check the correct temper of a cold chisel for the work in hand.
4. Why some jobs are not done with a cold chisel. (Removing rivet and bolt heads. Cutting wire on a hardened surface. Other examples.)
5. The correct direction in which to chip.
6. How to hold the work securely while chipping.

C. Demonstration by the instructor:

1. The correct method of holding work in a vise. (Safety)

2. How to smooth the edge of a steel plate and scribe a line 3/16" fr the platc edge.
3. How to select the correct type of chisel for the work being demonstra (Explain why.)
4. How to chip the edge of the plate to the line. (Give reason for tak several cuts.)
5. How to hold chisel to prevent "hogging in" or "running out".
6. Correct "stance".

   Repeat previous items with cast iron; compare thc difference in c and the difficulty in cutting straight.

D. Student practice:

1. Have each trainee select a plate (either iron or steel) and proceed his own" according to instructions.
2. Observe each trainee for a brief time and correct procedure if necess
3. Change trainees around in order to provide experience on every of job.
4. Have the group assemble, each one with his work in hand; criticise compare. Invite trainees to discuss their work regarding:
   a. Difficulties encountered.
   b. Objections to the type of work.
   c. Preference for other types of work.
5. Point out the necessity and desirability of being familiar with, and sk ful in, the use of all types of cold chisels.
6. Switch to other types of cold chisels. (Cut grooves and fillets, and cha e corners.)
7. Call for volunteers to cut an oil groove in a bearing. (Have other t in ees watch.)
8. Examine all cold chisels that have been used by trainees to discover h condition of the cutting edges. Discuss the probable cause of the co di tion of the cutting edges.

V. Assignment:

Divide the class into groups of two or three. Assign to each group a smal o to be laid out and cut with a cold chisel. Have each man take his turn. Av each man cut his initials on the work before the job is considered fini ed Encourage the trainees to examine the work of the other men.

VI. Time — 6 to 9 hours.

TOPIC NO. 11

TOPIC — Open-end Wrenches.

TOOLS AND EQUIPMENT

1. Set of open-end wrenches
2. 6″ scale
3. 4″ outside calipers
4. Several damaged open-end wrenches
5. Piece of pipe

SUPPLIES

Assortment of square and hexagon nuts, and bolts to suit

A number of bars drilled to accommodate various diameters of bolts

A few studs

REFERENCE — *Shipyard Outside Machinist*, page 40.

INSTRUCTIONAL AIDS:

A. Wall chart (if available).

B. Engineer's Handbooks (if possible).

1. *American Machinsts' Handbook*, Colvin and Stanley, McGraw-Hill, New York.
2. *Machinery's Handbook*, The Industrial Press, New York, N. Y.

TEACHING HINTS:

A. Safety:

Stress the importance of avoiding skinned knuckles, bad falls, collisions with other workmen, and infections.

B. Information to be presented:

1. Styles, sizes, and markings of open-end wrenches.
2. Materials from which open-end wrenches are made.
3. Purposes for which open-end wrenches are intended.
4. Amount of strain the ordinary wrench will withstand.
5. Advantages of open-end wrenches.
6. Disadvantages of open-end wrenches.

C. Demonstrations by the instructor:

1. How to measure the outside diameter of a bolt.

2. How to calculate the size of the nut across the flats. (Have members the class supply necessary information.)
3. How to fit a nut to the selected bolt (square or hexagon).
4. How to measure the nut across the flats, not the corners (square hexagon).
5. Comparison of the size of the nut with the figures on the blackboard
6. How to substantiate measurement by referring to the handbook. (Sh the group how to use the handbook.)
7. How to select a correctly stamped wrench from the wrench set and ch it for size against the nut. (Some wrenches are stamped with the b size. Other wrenches are stamped with the width of the opening in wrench. Explain this.)

   Place a bolt through a suitable hole in the bar mentioned in the sec item listed under "Supplies", run the nut on, and tighten with a wren
8. How a second wrench is used to keep a bolt from turning. Use a sec wrench to hold the bolt head.
9. How to apply a jam nut (half-nut) to a bolt to lock a nut into plac
10. How to select a stud and screw it into place by means of a nut and h nut on the stud.
11. How and when to use a pipe over a wrench handle.

D. Student practice:

1. Have trainees measure bolts and find the correct size of nut.
2. Divide the class into groups and have each group work with a bar several bolts.

   (The holes in the bar should be close enough together to demonst fully the advantage of the offset handle of the wrench.)
3. Have each trainee experiment with applying a half-nut.

   Discuss the procedure with the group and make criticisms. Exh damaged wrenches and state probable cause for damage.
4. Have certain trainees place pipe over wrench handle and pull nut tight. (Explain that this has to be done in certain instances.) Point ou how easy it would be to twist off the bolt or ruin the wrench ha this way.

V. Assignment:

Throw an assortment of bolts and nuts into a pile, and with three trainee at the pile, check the number of bolts that can be fitted with nuts correctly in minute. (No measuring required or allowed.) Repeat with other trainees

VI. Time — 3 to 6 hours.

TOPIC NO. 12

Topic — Drills and Drilling.

Tools and Equipment

. An assortment of drills (straight and taper)

. Drilling machine (air or electric)

. Bench and vise

. 6″ scale

. Center punch and hammer

. 6″ dividers

. Assorted sizes of C. R. steel for use as plug gauges

. Taper sleeves for drill chuck

. Cutting oil and can

Supplies

Several steel plates of various thickness and sizes

Chalk

Some cast-iron plates or bars.

Some broken or damaged drills

Reference — *Shipyard Outside Machinist,* page 41.

Instructional Aids:

A. Cleveland Twist Drill wall chart.

B. Tool catalogs (showing drills):

1. Union Twist Drill Co., Cleveland, O.
2. Cleveland Twist Drill Co., Cleveland, O.

Teaching Hints:

A. Safety:

Cover every angle of safe practice which should be followed in the use of a drill or drilling machine.

1. Use a sharp drill.
2. Tighten the drill chuck securely to keep the chuck from slipping and to prevent possible loss of balance if the drilling machine loses its grip on the drill shank.
3. Raise or lower a drilling machine by means of a line; never use the air hose to do this.

4. Be sure the drill cutting edges are "backed off" to avoid "hoggin when following a pilot hole.
5. Ease up on the feed to avoid a sudden jolt when the drill cutting are almost through the work.
6. Have the drilling machine in position and the drill point on center b setting the machine in motion.
7. Inspect the hole location carefully to avoid drilling into electric c or conduit.

B. Information to be presented:

1. The cutting action of a twist drill.
2. Why a drill cuts true to size.
3. Cross section of a drill, the temper, torque, and strain limit.
4. How a drill may be "burned"; and how to prevent it.
5. The difference in R. P. M. of small drills and large drills.
6. The meaning of cutting speed.
7. The use of pilot holes.
8. The proper lubrication of drills.
9. Drill sizes and clearances.
10. A drive fit; a force fit; an easy fit.
11. How the speed of a drill is found (R. P. M.) for specific materi
12. The comparative economic values of carbon and high-speed drills

Review this lesson to be certain each trainee understands the cut

C. Demonstration by the instructor:

1. How to lay out a hole location on a steel plate.
2. How to drill the hole. (Proceed slowly enough for every trainee to sorb the instruction. Stop and explain until each trainee thor ig understands "why".)
3. Repeat all the moves except drilling the hole. When ready to b drilling the next hole; —
4. Hand the machine to a trainee and let him try his skill. Assist in necessary.

(When the hole is drilled proceed with the next trainee.)

5. Have the first trainee who drilled a hole instruct another member of the group in the correct way to prepare to drill a hole.

   (Check up on the instructions as he proceeds, making necessary criticisms.)

6. Start a hole and show the trainee how to "draw" it to center or away from center. (Let trainee practice doing this.)

7. The use of a pilot hole.

8. How to check a drill for equal length of cutting lips.

D. Student practice:

Divide the class into groups of three. Have each group drill three holes, taking turns as each hole is drilled. The instructor will criticize.

ASSIGNMENT:

Have each trainee answer the questions on page 45 of the *Shipyard Outside Machinist* manual. Distribute paper.

TIME — 9 to 12 hours.

TOPIC NO. 13

I. Topic — Reamers and Reaming.

II. Tools and Equipment

1. Assorted reamers
2. 6″ scale
3. Hand-reamer wrench
4. Combination square

Supplies

Several plates with drilled holes to be ream

Dummy pedestals, chocks, and foundations

Short, round bars with holes drilled for rea n to taper-pin sizes

Assortment of taper pins

Short pieces of shafting (rods) to fit reamed o

III. Reference — *Shipyard Outside Machinist,* page 47.

Instructional Aids:

A. Tool catalogs

1. Union Twist Drill Co., Cleveland, O.
2. Cleveland Twist Drill Co., Cleveland, O.

B. Wall chart of taper pins (when obtainable).

C. Rods, shafts, couplings, and universal joints assembled with taper pin

D. Some parts which have been reamed and drilled to mate, but whic a not assembled.

IV Teaching Hints:

A. Safety:

Stress the importance of safe practice in the use of a drilling machine.

1. Be sure of firm footing when reaming.
2. When reaming overhead wear goggles to protect the eyes from ch s.
3. Hold the drilling machine true to prevent breaking the reamer a d avoid the possibility of a fragment of the broken reamer flyin a injuring the operator or nearby workmen.
4. Have the drilling machine in position and the reamer point in p iti before setting the machine in motion.
5. Ease up on the feed to avoid a sudden jolt when the reamer is m through the work.

6. Tighten the drilling-machine chuck securely to keep the chuck from slipping and prevent possible loss of balance if the drilling machine loses its grip on reamer shank.

B. Information to be presented:

1. Types of reamers and their uses as outlined beginning on page 47 of the *Shipyard Outside Machinist* manual.
2. Correct manner of holding work and reamer.
3. The cutting action of reamers.
4. The care of reamers.
5. How to prevent broken reamers. Report breakage if it occurs.

C. Demonstration by the instructor:

1. How to hold a reamer correctly when reaming.
2. How to prevent damage to and breakage of reamers. State avoidable causes of damage.
3. How to select the correct reamer for a given size of taper pin.
4. The effect of a poor-fitting hand-reamer wrench on the reamer square.

D. Student practice:

1. Have the trainees handle reamers and ask questions.
2. Ask various members of the group to name certain reamers and state their uses.

ASSIGNMENT:

Use a separate sheet of paper and have trainees answer the questions to be found on page 48 of the *Shipyard Outside Machinist* manual.

TIME — 9 to 12 hours.

TOPIC NO. 14

I. Topic — Reaming "Through" Holes.

II. Tools and Equipment

1. ¾" straight-flute hand reamer.
2. ¾" spiral-flute hand reamer.
3. #4 taper hand reamer, spiral flutes.
4. 6" scale.
5. 4" outside calipers.
6. ½" taper machine reamer, spiral flutes.
7. Drilling machine.
8. Reamer wrench.
9. Drill for #4 taper pin.
10. Bench and vise.
11. Center punch and hammer.
12. C-clamps.
13. 23/32" drills.
14. Open-end wrenches for ¾" and ½" standard nuts.

Supplies

Iron or steel couplings bored 23/32" n side diameter.

Steel plates drilled 23/32".

Steel plates drilled 15/32".

Cast-iron bars 1½" x 2" with 23/3 and 15/32" drilled holes.

Steel plates drilled.

Brass couplings bored 23/32" inside ia meter.

¾" C. R. rods.

Steel plates with 7/16" holes drilled an edges and plates riveted or weldec to gether in pairs with the holes al os lined up.

Quantity of ½" bolts 1½" long.

Two dozen #4 taper pins.

Wood blocks cut out half-round to ol couplings and rods.

Bushings for ¾" hole ⅜" inside diam ter

Chalk.

Two dozen ¾" fitted bolts .7505" ou side diameter.

Two dozen black bolts.

III. Reference — *Shipyard Outside Machinist,* page 50.

Instructional Aids:

A. Specimens of reamed holes with fitted bolts.

B. Specimen couplings with fitted shafting, taper pins in taper holes, ate reamed to take ½" bolt.

C. Wall charts showing various fitted bolts and reamed parts.

TEACHING HINTS:

A. Safety:

1. Review safety as in Topic No. 14.
2. Stress the hazards of loose clothing, careless handling of drilling machine, and dull tools.

B. Information to be presented:

1. The meaning of "amount of stock on a side" to be reamed.
2. How to determine the speed of a reamer.
3. How to determine correct feed.
4. How to drill through a guide hole.
5. How to drill through a hole in a bushing.
6. How to drill for a bushing size (to be reamed.)
7. Spiral flute compared with straight flute.
8. How to hold a drill or reamer true and steady to prevent breakage. (Leaning the reamer to bring the hole to position is not good practice. Breakage is likely.)
9. Lubrication.
10. Breakage of small-diameter drills.
11. Use of reamer to enlarge mismatched holes where a drill would break if used to do the same job.
12. Securing drill or reamer tightly in drill chuck.
13. Damage resulting from allowing drill or reamer to turn in the chuck.
14. Correctly ground drills and reamers.
15. Difference in drilling and reaming cast iron, steel, and brass.
16. Care of tools.
17. Action of reamer when reaming:

    A. By hand.

    B. By machine.

C. Demonstration by the instructor:

1. How to secure drill or reamer in chuck.
2. Proper way to hold the drill or reamer to the work.

3. Correct method of lubrication.
4. Correct way to stand in order to steady the tools.
5. Necessity for adjusting light, or work, to be clearly seen.
6. How to secure the work so as to prevent its moving out of place wh it is being drilled or reamed.
7. How to drill, ream, and fit a bolt.
8. How to drill, ream, and fit a taper pin.

Allow plenty of time for trainees to ask questions, and check frequen to make sure the instruction is clearly understood.

D. Student practice:

1. Have trainees work on previously planned jobs of drilling, reaming, a fitting shaft and pin.
2. Have the trainees work individually or in small groups until each m can carry through a series of operations without much assistance. Cr cize trainee's work.

V. Assignment:

This should be a job of such a nature that each trainee will be required t think his way through. Several simple drilling and reaming jobs should e planned in advance, and the trainee should work from a blueprint or sket

Use typical examples of work that is frequently done in the shipyard. S gested examples follow:

1. Lay out, drill, and ream for a taper pin in an operating rod and coupli
2. Lay out, drill, and ream a base, chock, and foundation.
3. Ream drilled holes in a bonnet to fit over studs in a valve-body flange
4. Select the correct reamer, and ream coupling holes for a snug fit to a $1\frac{1}{4}$" shaft.

VI. Time — 9 to 12 hours.

TOPIC NO. 15

Topic — Using a Portable Air Drill.

Tools and Equipment

1. A portable air drill
2. A corner drilling machine
3. A drilling post
4. 15/16″ drills, ½″ drills
5. 6″ scale
6. A drilling stick
7. C-clamps
8. Hook bolt to use with a drilling stick
9. Bolts and nuts for securing drilling machine to the work
10. Center punch and hammer
11. 1″ spiral-fluted reamer
12. 1″ straight-fluted reamer

Supplies

¾″ steel plates 18″ x 36″

Mock-up pedestals with corner holes drilled and provisions made for clamping pedestal to foundation

½″ bushings to fit 15/16″ holes

Quantity of 1.00025 fitted bolts (correct length)

Quantity of 1″ black bolts (correct length)

Chocks (3″ x 4″)

Oil can and cutting oil

Reference — *Shipyard Outside Machinist*, page 55.

Instructional Aid:

A pedestal drilled and secured to a foundation with fitted bolts (cross section).

Teaching Hints:

A. Safety:

Stress safety practice as outlined for Topic No. 14.

B. Information to be presented:

1. The conditions under which a portable air drill and a corner drilling machine are used.
2. The limited working space that may exist on some jobs. Illustrate, by blackboard sketches.
3. The steps necessary to prepare for:
   a. Drilling holes in a pedestal.
   b. Drilling holes in a foundation.
   c. Drilling holes in a deck plate.
   d. Drilling holes in a corner.

4. How "cramping" the drill may cause breakage. Give examples.
5. Examples of drilling holes in a horizontal, an overhead, and an incli position.
6. Where lubrication is necessary.

C. Demonstration by the instructor: (Have trainees assist.)

1. How to hold the air drill, corner drilling machine, and drilling stick
2. How to set up a drilling post in readiness for supporting an air dr
3. How to adjust the air drill under the arm of the drilling post.
4. How to arrange the equipment for safe operation.
5. How to drill a hole.
6. How to set up the air drill for drilling through a pedestal.
7. How to drill a foundation and use a bushing while drilling the pilot he
8. How to drill through the foundation following the pilot hole.
9. How to lay out and drill a chock.
10. How to ream through the pedestal, chock, and foundation.
11. How to install a black bolt.
12. How to remove a black bolt and install a fitted bolt.

Repeat the above as far as is necessary to demonstrate the use of he corner drilling machine and the use of the drilling stick.

D. Student practice:

1. Have trainee select drill and secure it in the air drill.
2. Have a second trainee assist in placing the drilling post.
3. Have trainees drill a hole in plate while the instructor coaches.
4. Have a third trainee set up the air drill and with the aid of a fourth trainee drill a hole in a plate.
5. Have a fifth trainee rig up a corner drilling machine.
6. Have a sixth trainee help the fifth trainee drill a hole in a suitable locaon
7. Have a trainee select a reamer, set up the air drill, and ream a few hes
8. Call for two volunteers to set up an air drill and drill a foundation ole correctly. (Use a mock-up.)

(Quiz the group as a check-up on the knowledge gained through the demonstration and practice.)

V. Assignment:

1. Have the trainees answer the questions on page 57 of *Shipyard Guide Machinist.*
2. If equipment is available, divide the class into groups and have them rill, ream, and bolt pedestal and foundation assemblies. A few plates may be drilled and reamed with the use of the drilling machine and stick.

VI. Time — 9 to 12 hours.

TOPIC NO. 16

TOPIC — Threading Bolts and Nuts.

TOOLS AND EQUIPMENT

1. Sets of American Standard taps
2. American Standard dies to suit tap sets
3. Assorted drills to suit tap sets
4. 6" scale
5. Center punch and hammer
6. 10" half-round bastard file
7. Die stocks
8. Bench and vise
9. Drilling machine

SUPPLIES

Cutting oil

Flat steel plate (for practice tapping)

Quantity of round stock (to suit dies), or old bolts that can be re-threaded

Quantity of nuts (to suit taps)

REFERENCE — *Shipyard Outside Machinist,* page 60.

INSTRUCTIONAL AIDS:

A. Wall chart (Screw Threads, Bolts, and Nuts), Machinery, Industrial Press, New York.

B. Cross-section screw thread and nut assemblies.

TEACHING HINTS:

A. Safety:

1. Avoid infection caused by skinned knuckles.
2. Beware of steel slivers in hands.
3. Hold work securely so as to prevent injury.

B. Information to be presented:

1. Size of nuts relative to diameter of bolts.
2. Why the drill size for a tapped hole is a standard amount smaller than the tap size.
3. The reason for, and the use of, three taps in a standard set.
4. The meaning of "lead" and "pitch".

5. The procedure for picking up from a blueprint the required informat for drilling and tapping a hole.
6. How to determine whether to re-tap the nut or to re-thread a bolt stud when the fit is too tight.
7. How a thread may be "stripped."
8. The correct procedure to follow when a stud or a bolt is too loos fit for a tapped hole or a nut.
9. The correct method of re-threading a bolt or stud if the end of the b or stud is battered badly.
10. The correct use of lubricants.

C. Demonstration by the instructor:

1. How to select a drill for a certain tap size and drill a hole.
2. How to tap the hole with a taper tap:
   a. How to line up the tap.
   b. How to turn the tap in to "cut" instead of "ream".
   c. How to "sight" the tap as it enters the work.
   d. How to apply lubricant at the correct time.
3. How to drill a hole (same size as in step 1) part way through a p (for a blind tapped hole).
4. How to use the taper tap first.
5. How to use a plug and bottoming tap.
   (Point out the precautions necessary to prevent tap breakage.)
6. How to try a bolt or a stud in the hole for a fit.
7. How to clean the taps before returning them to the box.
8. How to chase the threads on a battered bolt or stud.
9. How to thread rods. (Use several rods.)
   (Explain how far the threads should be run up and state reasons.
10. How to tighten a nut and a half-nut.

    Select two pieces of stock, drill holes to suit the bolt, and show h correct way to lock the nut.

    Point out the danger of excess strain on the bolt:

    a. Stripped threads
    b. Bolt may be twisted off or a crack started
    c. Nut may be ruined (if it is small)

    (Review)

D. Student practice:

1. Divide the class into groups and have the trainees drill and tap holes.

   Create conditions as much like actual working conditions as possible. Vertical, horizontal, and slanting holes should be drilled and tapped.

2. Have trainees:
   a. Thread several rods
   b. Re-thread several battered bolts
   c. Re-tap battered nuts

3. Have trainees bolt together with correct size of bolts several previously prepared pieces of plate.

   (Check the work for accurate fits, properly tightened nuts, and correct lengths of bolts.)

ASSIGNMENT:

1. Have the trainees work from a blueprint and lay out, drill, and tap a mock-up bulkhead to receive a watertight cover and gasket.

   (A job should be provided for each trainee; or, trainees may work in small groups and each trainee take his turn on the job.)

2. Have trainees answer questions on page 62 of the *Shipyard Outside Machinist* manual.

TIME — 9 to 12 hours.

TOPIC NO. 17

I. Topic — Tightening a Stud in a Threaded Hole.

II. Tools and Equipment

1. Set of open-end wrenches
2. Several stud drivers
3. 6″scale
4. Stillson wrench
5. Screw pitch gauge
6. Machinist's hammer
7. Bench and vise

Supplies

Several steel plates or bars with tapp holes of the stud size to be used.

White lead.

III. Reference — *Shipyard Outside Machinist,* page 65.

Instructional Aid:

Examples of studs installed in a mock-up.

IV. Teaching Hints:

A. Safety:

1. How to avoid skinned knuckles.
2. How to avoid getting steel slivers in the hands. Infection can result fr n these injuries.

B. Information to be presented:

1. How to fit studs tightly in a threaded hole to prevent backing out w n removing the nut from the exposed end.
2. Why a Stillson wrench mars the studs.
3. Why using a Stillson wrench may bend the stud.
4. Why a Stillson wrench should never be used unless there is plenty of space to get a grip and the stud is large.
5. Text material in the manual should be reviewed.

C. Demonstration by the instructor:

1. How tc prepare a stud driver and stud to be screwed into a tapped hle.
2. Why the hole is inspected before installing the stud.

3. How to install the stud according to the instructions given in the manual.
4. How to remove the stud driver.
5. How to place a suitable collar over the stud and tighten a nut down to prove the stud is securely anchored.
6. How to back up with a half-nut.
7. How to remove the half-nut and nut.
8. How to remove a stud with the stud driver.

D. Student practice:

Have the trainees prepare stud drivers and studs and proceed as in Paragraph C from step 1 to the end. The instructor will criticize and assist the trainees.

ASSIGNMENT:

1. Call on the trainees to review the procedure.
2. Select a trainee to demonstrate the procedure to the class.
3. Have the trainees answer the questions on page 64 of the *Shipyard Outside Machinist* manual.

TIME — 3 to 6 hours.

TOPIC NO. 18

I. Topic — Removing Studs or Broken Bolts.

II. Tools and Equipment

1. Stillson wrench
2. Cold chisel (1″ flat)
3. Machinist's hammer
4. Center punch and prick punch
5. 4″ dividers
6. Drill (according to size of broken stud)
7. Assorted sizes of easy-outs
8. Hack saw
9. Tap wrench (to fit easy-out)
10. Drilling machine
11. Goggles
12. Set of taps
13. Screw pitch gauge
14. 10″ flat bastard file

Supplies

Chalk

Several steel or iron
in which are broken

(Prepare the exampl
broken-off studs by s
ing the stud into th
ped hole extra tigh

III. Reference — *Shipyard Outside Machinist,* page 67.

Instructional Aid: A plate from which broken studs have been removed
also the broken studs which were removed.

IV. Teaching Hints:

A. Safety:

1. Wear goggles when chipping or while helping on a chipping job.
2. Be patient when working on this job. Nothing is gained by bec
impatient and working roughly.

B. Information to be presented:

1. The reasons why studs are broken off.
2. The care that should be used not to damage finished surfaces w
removing a stud.
3. Two ways of removing broken studs (with gouge, chisel, and eas
Discuss the merits of each method.
4. The text material in the manual should be reviewed and the tri
should be drilled in the several steps.

C. Demonstration by the instructor:

1. How to remove an especially difficult stud.

   Allow each trainee to handle and examine an easy-out.

   Point out the direction of the flutes on the easy-out.

2. How to remove a stud (drill-out method).

3. How to remove a stud (easy-out method).

D. Student practice:

1. Have each trainee chip a stud level with the surface of the plate and smooth with a file.

2. Have each trainee find the center of a broken stud and center-punch the drilling center.

3. Have a number of the trainees drill the stud end while others prepare more surfaces.

4. Change groups and proceed with more chipping and drilling.

5. Help the trainee split the shell from the hole. (Criticize while the trainee does the work.)

6. Have the trainee try the easy-out method. (Give warning here to avoid a broken easy-out.)

7. Have trainees try bolts or studs in the threaded hole after the stud is removed to check for a clean hole. Use a tap to clean the hole if necessary.

ASSIGNMENT:

Have ready a mock-up or an actual example of a flange that is bolted to another flange. This job should have been prepared without applying any lubricant to the studs when they were installed. Be sure the studs are well rusted into the threaded hole. The nuts on the clamping end of the stud should be an extra-tight fit. A large flange with 24 or more studs is desirable. About half of the studs should be broken off.

1. Have each trainee take his turn in removing a nut.

2. Have each trainee take his turn in removing a broken stud.

TIME — 3 to 6 hours.

TOPIC NO. 19

I. Topic — Screwdriver.

II. Tools and Equipment

1. Several screwdrivers of various sizes
2. A few badly damaged screwdrivers for exhibition
3. 6″ scale

Supplies

Wood blocks

Steel plates tapped for machine sc (stamp pitch of thread beside ta holes)

III. Reference — *Shipyard Outside Machinist,* page 69.

Instructional Aids

A. Wall chart of screws (all kinds).

B. Wood block into which have been screwed a number of flathead and ro head screws.

C. A steel plate into which have been screwed a number of countersunk- screws and roundhead machine screws.

IV. Teaching Hints:

A. Safety:

1. Injuries can result from carelessly held screwdrivers.
2. Infections are often caused by steel slivers from screwheads.

B. Information to be presented:

1. How to identify screw sizes.
2. How to measure the lengths of screws.
3. Nomenclature of screws:

a. Wood screws

(1) Flat head	F.H.Bright
(2) Round head	R.H.Blued

b. Machine screws

(1) Round head	R.H.M.S.
(2) Countersunk head	Csk. Hd. M.S.

4. Why the screwdriver must fit the slot in the screwhead.

   If the screwdriver does not fit the screwhead, steel slivers will be "chewed" off and the screwhead will be ruined.

5. The correct size of screwdriver to fit the screw.

   Never use a small screwdriver with a large screw. Do not try to force a thick screwdriver into a screwhead slot.

6. Meaning of the terms "pass hole" and "anchor hole".

C. Demonstration by the instructor:

1. How to identify screw sizes by sight.
2. How to drive several screws into a wooden rail.

   Show what happens when the workman tries to fasten two pieces of wood together without first drilling a pass hole in the piece to be screwed on. Show what happens when the workman tries to turn a large screw into the wood without first drilling an anchor hole to keep the work from splitting.

3. How to identify machine-screw thread pitches and machine-screw diameters by sight.
4. How to determine the size, diameter, and depth of the pass hole for a certain-sized screw.

D. Student practice:

1. Have the trainees try to select wood and machine screws by sight.
2. Have each trainee drive a number of screws into a wooden block.
3. Have trainees use machine screws. (Suitable jobs should be available for this practice.)

ASSIGNMENT:

1. Divide the class into groups of two.
2. Give each group a previously selected number of wood and machine screws, blocks of wood, and suitably chosen metal plates to be fastened together. There should be more screws than necessary for the job, and many of the screws should be of a size that is not intended for the job.
3. Set a given amount of time for the assigned jobs.
4. Explain thoroughly what is to be done.
5. Give each group a screwdriver kit and appoint one of each group to act as referee. Inform the class that when "time" is called, the worker and the referee should change places and complete the assignment. Two jobs of the same kind are given each pair of trainees.
6. Inspect the work and credit each job according to merit.

TIME — 1 to 2 hours.

TOPIC NO. 20

I. Topic — Files.

II. Tools and Equipment

1. Large assortment of files to be selected by the instructor to suit his problems
2. Bench and vise
3. 6″ scale
4. 4″ outside calipers
5. Center punch
6. Machinist's hammer
7. Scriber

Supplies

Large quantity of strips of plate ¼ thick and approximately 1 wide

Chalk

Some brass bars (if available)

Quantity of cast-iron bars

Quantity of cast-iron bars with 1 edge machined

Pieces of work that have been fi straight and square

III. Reference — *Shipyard Outside Machinist*, page 70.

Instructional Aid: Wall chart, Nicholson File Co., Philadelphia, Pa.

IV. Teaching Hints:

A. Safety:

1. Never use a file without a *GOOD* handle.
2. Beware of wiping filings into the eyes, or of getting filings into cuts on the hands.

B. Information to be presented:

1. What a careful examination of files will reveal.
2. The harmful results of trying to file hardened steel or hard-scale surfa of cast iron.
3. How file strokes should be taken. Illustrate on blackboard.
4. The file has a cutting surface for almost the entire length.
5. Files are often thrown away as useless when they can be made to las longer by using the entire cutting length.
6. The edges of most files are also useful.

C. Demonstration by the instructor:

1. The correct standing position when filing.
2. How to hold the file correctly:
   a. To file straight
   b. To file with the least fatigue
3. The several jobs for which the different types of files are used.
4. How chalk, scale, scriber, and center punch are used to lay off a line to follow when filing.
5. How to file a piece of material to a line.
6. How to use the scale to check the edge which should be straight.
7. The filing speed of steel, cast iron, and brass.

D. Student practice:

1. Have trainees lay off lines on the edge of a piece of stock.
2. Have trainees place the stock in the vise and practice filing to a line.
3. Have trainees check work with scale to find out if it is straight.
4. Drill trainees thoroughly until they can do a good job on a six-inch piece of work.

ASSIGNMENT:

(Have ready several pieces of material with lines laid off and center-punch-marked.)

1. Require each trainee to file his job to the line and keep a record of the time.
2. Have each piece of work marked so that individual work may be identified.
3. Pass the work of each trainee to the next man and ask for constructive criticism.
4. Have trainees answer the questions on page 71 of the *Shipyard Outside Machinist* manual.

TIME — 9 to 12 hours.

TOPIC NO. 21

I. Topic — Fitting a Key.

II. Tools and Equipment

1. 10″ flat mill file
2. 6″ scale
3. Drift
4. 1½-lb. machinist's hammer
5. Bench and vise

Quantity of keys (plain and gib-head)
White lead
Shafting and couplings

III. Reference — *Shipyard Outside Machinist,* page 74.

Instructional Aids:

Specimens of keys fitted to couplings and shafts.

IV. Teaching Hints:

A. Information to be presented:

1. Types of keys and uses.
2. Materials from which keys are made.
3. Shearing strains on keys.
4. Effects of poorly fitted keys:
   a. On the key
   b. On the keyway
   c. On the usefulness of the job
5. How to tell if a key is correctly fitted.

B. Demonstration by the instructor:

1. How to check the coupling, key, and shaft with the blueprint.
2. How to prepare a key for the keyway and coupling. (Chamfer the ends; break the sharp corners.)
3. How to fit the key to the job. (Gib key)
4. How to start the key in the coupling and shaft keyway.
5. How to apply the white lead and drive home.

6. How to draw the key with the drift.

   Point out the scores on the key. Repeat the demonstration with a plain key.

7. How to remove the coupling from the shaft.

C. Student practice:

Distribute keys, files, couplings, and shafts to the trainees.

1. Have trainees fit gib keys.

   (Help the student as little as possible.)

2. Have trainee repeat the practice with plain keys.

3. Have the trainees remove the coupling from the shaft after the key has been driven home.

. ASSIGNMENT:

1. Have the trainees answer the questions on page 73 of the *Shipyard Outside Machinist* manual.

2. Divide the class into groups of two and have each pair of trainees fit various keys to previously prepared couplings and shafting.

   Set a time limit for each job. See that the trainees take turns at the job.

. TIME — 9 to 12 hours.

TOPIC NO. 22

I. Topic — Miscellaneous Hand Tools.

II. Tools and Equipment

A. Complete line of tools listed in "Miscellaneous Tools" as follows:
1. Combination square
2. Hack saws
3. Tin snips
4. Knife
5. Scriber
6. Level
7. Plumb bob and line
8. Thickness gauge
9. Adjustable wrench
10. Stillson wrench
11. Monkey wrench
12. Pliers
13. Twelve-point box wrench
14. Calking tools
15. Fox wedges
16. Chalk line
17. Drifts
18. Hand scrapers
19. Three-cornered scraper
20. Straight scraper
21. Straight packing hook
Screw packing hook
22. Drift punch
23. Goggles
24. Oilstone
25. Hexagon socket wrench
26. Socket wrenches
27. Hexagon box wrench
28. Trammels
29. Straightedge

B. Benches
C. Vises
D. C-clamps
E. Files
F. Machinist's hammers
G. One or more large surface plate
H. Center punch
I. Taper gauge

III. Supplies

A. Iron blocks
B. Pipe
C. Sheet metal
D. Chalk
E. Quantity of wooden wedges
F. Plumb line
G. Small mock-ups of rotors and stators
H. Actual rotor and stator assembly
I. Blocks with several firmly anchored studs
J. Pipe couplings
K. Soft wire
L. Steel plates (drilled and tapped, and mating plates to be bolted together)
M. Pairs of plates riveted together suitable for calking
N. Valves or mock-ups of valve bonnets bolted in place
O. Steel plates drilled in stagge fashion
P. Babbitted bearings
Q. Brass bearings
R. Iron bearings with shafting to
S. Stuffing boxes and packing
T. Several bars drilled for tapered i of various sizes.
U. Large assortment of hexagon n
V. Large assortment of bolts and s
W. Several large sheets of black ir other available sheet metal
X. Assortment of Allen set screws n socket-type cap screws
Y. Several iron blocks of carefully n chined iron or steel
Z. Shim stock .0015" to .005"

IV. Reference — *Shipyard Outside Machinist*, page 75.

Instructional Aids

A. All available wall charts and photographs of operations showing the s of the tools listed above.

B. Movies of assembly and disassembly of various pieces of equipment. (To be made locally)

C. Movies of the use of tools (close-ups) in the installations of equipment aboard ship. (To be made locally)

TEACHING HINTS:

A. Safety:

The instructor should prepare a list of all possible and probable hazards encountered while performing operations with the various tools to be used in the presentation of the information and demonstrations covered by this section of the *Shipyard Outside Machinist* manual. These hazards may be discussed at the same time the use of tools is presented. A general discussion of the dangers of slight injuries that may result in infection and of the responsibility of each workman for the protection of fellow workmen should be given immediately.

B. Information to be presented:

This calls for careful preparation. Suggestions are made here that should lead to the successful training of the students in the use of the several tools. The instructor should use his ingenuity in the planning of practice work, which is so nearly the same as actual performance on the job that the trainee will be thoroughly acquainted with tools and operations when he encounters them on his first job. Each trainee may be taught to work with different tools from those used by his neighbor.

1. The combination square, protractor, and center head.

SUGGESTIONS:

a. Have a trainee use a file and a combination square to square the edge of a cast-iron or steel block while it is held in the vise.
b. The center head, scriber, and center punch may be used to find the center of several round shafts.
c. Give the trainee several angles to lay off on a piece of sheet metal. Use a protractor.

2. The hack saw

SUGGESTIONS:

a. Have a trainee measure off and saw specified lengths of pipe, shafting, and square stock.
b. Have the trainee saw steps in the ends

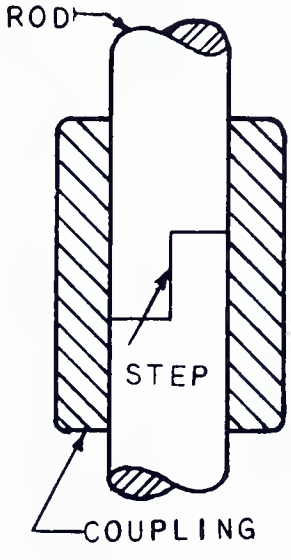


FIG. 2 — *Operating-Rod Steps*

of operating rods (short lengths), and file the steps to an exact lap. See Fig. 2. Check the accuracy of the work by trying the for a fit in an iron sleeve which has been reamed to the correct

c. Have the trainee lay out a square notch on a steel plate. Cut out and file to fit a square shaft. The surfaces of the square must fit flush with the edges of the plate as shown at the right in Fig. 3. The square shaft must also fit the square notch snugly. The notch should be sawed out so nearly square and so nearly to size that a minimum of filing is necessary.

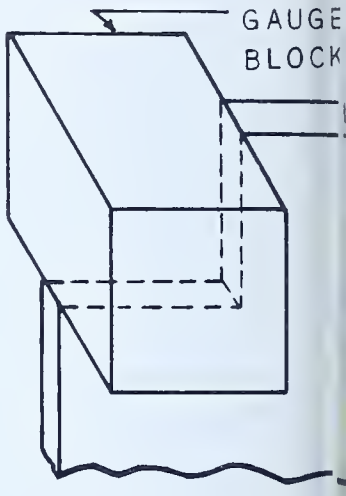


FIG. 3 — *A Notch Filed Square to Block.*

3. The tin snips

SUGGESTIONS:

a. Have the trainee lay out circles of various sizes on a sheet of gasket material (cardboard may be substituted). The circles must be cut with the tin snips exactly on the scribed line.

b. Have the trainee lay out circles 8″ in diameter with tangent circumferences. See Fig. 4.

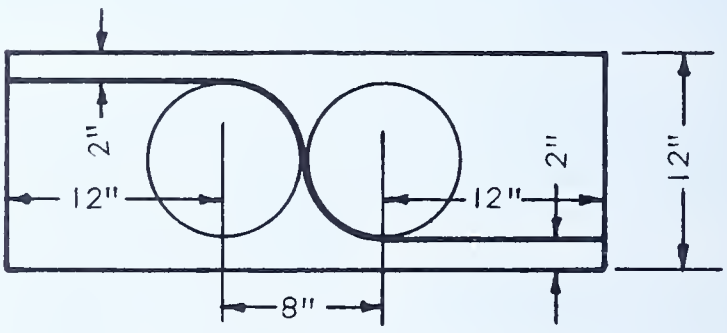


FIG. 4 — *A Layout on Gasket Material.*

The centers and boundaries of the figure must be accurately scribed. The figure is then cut out on the heavy line. After cutting out the line, reverse one half, and place it on the other half. If the work has been carefully done, the two halves should fit very closely

c. Procure sheets of cardboard or linoleum. Have the trainee lay out two concentric circles, 6″ and 3″ in diameter, respectively. Cut the outside diameter to the line with the tin snips, and the inside diameter to the line with the knife. Compare several rings thus cut and check for the accuracy of the jobs.

4. The scriber
5. The level

SUGGESTIONS:

a. Procure a sheet of aluminum, galvanized iron, or black iron. Have the trainee nail the sheet of metal in a vertical position at a convenient height. See Fig. 5. With the level and the scriber, scribe vertical and horizontal lines making four right angles.

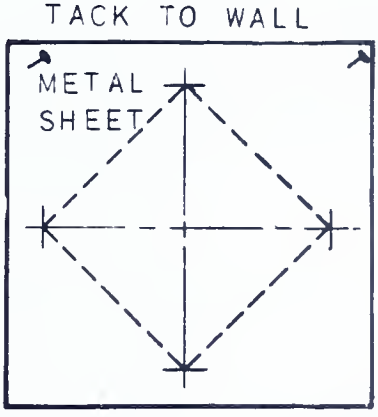


FIG. 5 — *A Layout*

b. Make four prick-punch marks on each branch of the crossed lines. With the dividers (or trammels) check the distances from point to point. See dotted lines, Fig. 5. The distances should check the same.

c. Have the trainee place two parallels on the bench or floor. Place a steel plate on the parallels. With the level placed correctly, level the plate on the parallels until it is level in all directions. (Use shim.)

6. Plumb bob and line

SUGGESTIONS:

a. Procure as many steel plates (3′ x 5′) as necessary. Have crosspieces welded to the 3′ edge of the plate on one end. See Fig. 6. From a convenient point above the plate, hang a plumb line and bob. With the wedges under the crosspieces, line up the plate until it measures parallel to the plumb line. Use a scale to measure.

b. Have trainee hang a second plumb bob and line at the side of the steel plate. With wedges, line up the plate endwise until the edge of the plate measures parallel with the plumb line. Re-check both the edge and the face of the plate until both are parallel with the plumb lines.

c. Have the trainee lay bars across the projecting ends of the cross bars to hold the assembly steady on the floor. Use the level to scribe three lines 6″ apart on the surface of the

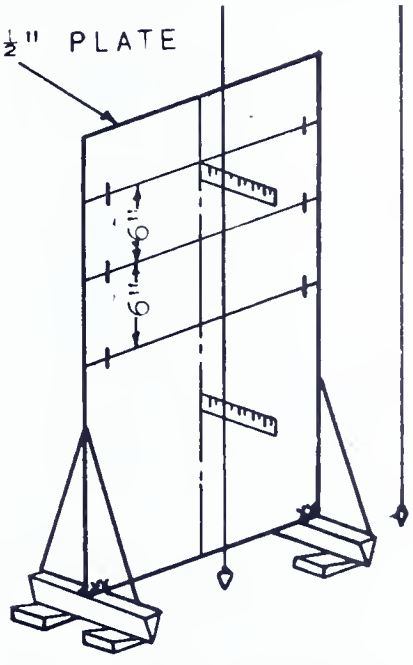


FIG. 6 — *Mock-up Bulkhead*

plate. Have the trainees make center-punch marks at the intersect
of the lines. Center-punch spots on either side of the center
Center-punch one spot near the floor on the center line. With
trams set in the lower center-punch mark on the vertical line, c
the center-punch marks on the three horizontal lines. The ce
punch marks on either side of the vertical line should check the s
proving that the work of scribing the lines has been done accura

7. The thickness gauge

SUGGESTIONS:

a. Place surface plates on the bench. Place iron blocks with mach
surfaces on the surface plate. Have the trainee check contact bet
the iron block and the surface plate. There may be very little s
between the surface plate and the iron block. Possibly the .0
feeler will not enter the slight space. There may be no space at
In either case the demonstration will prove that such close sp
may be checked and detected.

b. Have the trainee prepare to check the opening between the rotor
stator of the mock-up. See Fig. 26. (The rotor should be slightly
of line when the trainee begins work.) Furnish the trainee wit
necessary tools, and have him true up the rotor with the stator.
instructor will show the trainee how to begin.

c. When the trainee believes his job is correct, have another tra
check the work for accuracy.

8. The adjustable wrench

9. The drift

SUGGESTIONS:

a. Have the trainee select two previously staggered drilled plates,
bring them to the bench. Select bolts and nuts. Bolts should fit
easily. One plate is placed in the vise. The second plate is line
with the first plate. Bolts are placed through the holes in the p
Square nuts are placed on the bolts only finger-tight. The drift is
to line up the holes. When all the bolts are in place, tighten the
with the adjustable wrench.

b. Have the trainee examine the wrench carefully. Point out the
fit of the adjustable jaw. Have the trainee take a strain on
with only half of the wrench thickness engaged. Have a
trainee measure the opening in the wrench jaws carefully to
that the jaws are not exactly parallel.

c. Have the trainee obtain two open-end wrenches to fit the nut and bolt head. Instruct the trainee to take a strain on the nut and hold the head of the bolt with a second wrench. This will prove that an open-end wrench will hold and pull more satisfactorily than will an adjustable wrench.

10. Stillson wrench

11. Monkey wrench

SUGGESTIONS:

a. Procure several pieces of 1½″ to 2″ pipe together with couplings, nipples, unions, and tees. Some of these pipe fittings and pipes may be assembled tightly. Have the trainee select certain fittings and pieces of pipe according to instructions. The trainee assembles the pipe and fittings according to sketches or blueprints which should be furnished by the instructor.

b. Have the trainees select a pipe fitting and pipe assembly for his instruction. While one trainee holds the assembly in place, the second trainee proceeds to disassemble the job. Different lengths of Stillson wrenches may be used on this job.

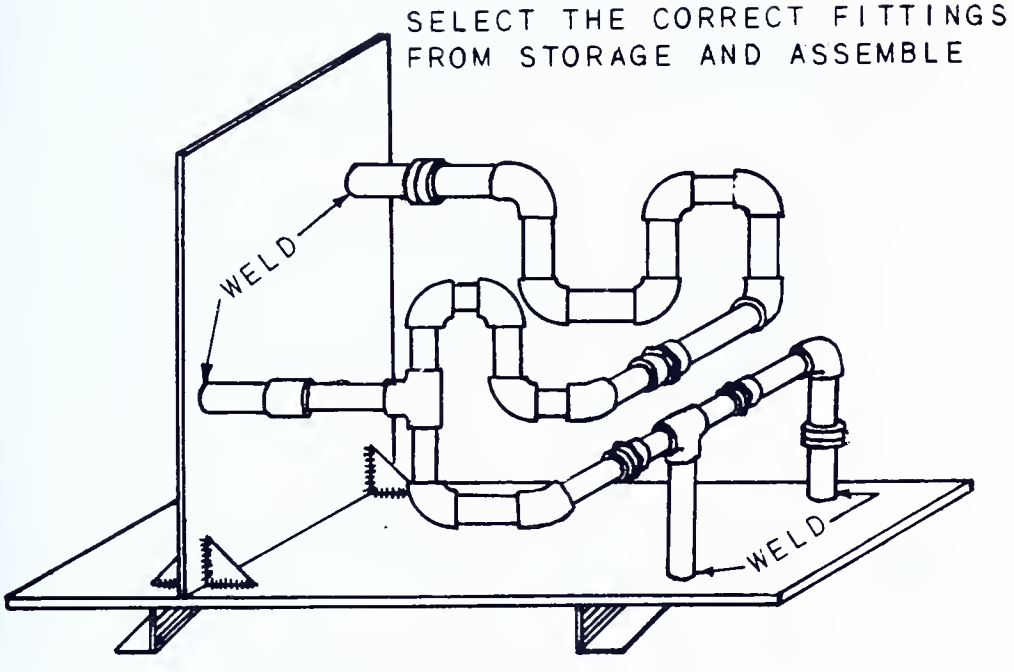


FIG. 7 — *Mock-up Pipe-connecting Job.*

c. Have prepared two sections of boiler plate, welded and gusseted as shown in Fig. 7. This piece of equipment is furnished with nipples

and flange pieces for the purpose of making connections. Have th trainees select several pieces of pipe and the necessary fittings a cording to instructions and then install and connect pipe and pi fittings according to blueprint or sketches furnished by the instructo Several of these pieces of practical equipment may be prepared make it possible for several trainees to work at the same time. Monk wrenches may be used in conjunction with the Stillson wrench whe the fitting of the pipe makes it necessary.

12. Side-cutting pliers

SUGGESTIONS:

a. The instructor should have ready various sizes and lengths of wi thin metal strips, common nails, and a quantity of medium-sized wo screws.

b. The instructor demonstrates how to hold the pliers in a manner whi will allow efficient manipulation with a minimum of danger fro injuries caused by pinching the fingers. The instructor should pl a series of uses for the pliers in connection with the current jo performed by the outside machinist. Any emergency uses of the sid cutting pliers should be noted and explained to the group.

13. Twelve-point box wrench

14. Fox wedges

15. Flat scraper

16. Drift punch

SUGGESTIONS:

a. Have ready various sizes of valves which are to be disassembled f inspection and repair. Have three trainees work together on the d assembling of each valve. Remove the nuts, set the box wrench, st the bonnet off by using the fox wedge, clean up the machined fa of the valve flanges with the scraper, and use the drift punch to ass in removing taper pins or bolts (if any).

b. Obtain steel plates which are drilled in pairs, one plate being drill and reamed to take ½″ cap screws easily, and the mating plate be tapped for a ½″ cap screw. The distance between the hol center to center, should be barely enough to allow a twelve-po wrench to be used for tightening up the hexagon cap screws th fasten the two plates together. Several cap screws should be start at intervals until the plates align. Then the balance of the cap scre are put into place, and the entire assembly is snugged home wi the twelve-point box wrench.

c. Have ready several short bars which are connected with pins and tight-fitting bolts. If some of these bolts and pins are rusted in, it will be helpful in demonstrating the use of the drift punch. Have the trainees work together in groups of two or three and remove the taper pins and tightly fitted bolts from their places in the couplings and shaftings. Do not allow the job to be held in the vise while the pins are being removed. The trainee should be shown how this job may be done under normal conditions. The instructor should have prepared as many examples as possible so that he can demonstrate the proper uses of these tools.

17. Straight-end and screw packing hook

SUGGESTIONS:

a. Have a large number of stuffing boxes ready, installed on pumps or shaftings. (Actual specimens should be used whenever possible. Stuffing boxes that are filled with old packing, which is difficult to remove, should be used wherever possible in classrooms.)

b. The instructor demonstrates the use of both straight-end and screw paeking hooks in removing old packing from a stuffing box. The trainees may be assigned to work in small groups in removing the packing and cleaning out the stuffing boxes ready to be repacked. The instructor should criticize constructively the movements of each trainee. The old packing should not be thrown around indiscriminately. This is a job where clean, neat workmanship is important.

c. Have the trainee switch to a stuffing box that another group has prepared for repacking. The trainee should be taught to measure for the packing, to cut off the packing rings, and to pack stuffing boxes according to instructions given in the manual *Shipyard Outside Machinist.* When the stuffing boxes are all packed, the trainees may be asked to assemble the work of other groups and offer criticisms.

18. Calking tools

SUGGESTIONS:

a. Procure pairs of steel plates riveted together and suitable for calking. If compressed-air calking tools are not available, the job will have to be done by hand.

b. Have the trainee secure the prepared plates in a suitable position for working, and demonstrate to the group the proper methods of using calking tools. The ingenuity of the instructor will have to be exercised in order to provide necessary variety of situations where calking

tools may be used to advantage. If an actual job can be set up in a classroom, or if the group can be conducted to a location where a job is ready for calking, the training given will probably be more effective.

19. Three-cornered scraper and straight scraper

SUGGESTIONS:

a. Have ready several babbitted bearings with the shafting to fit. When the shaft properly blued in spotting the surface, demonstrate to the group the procedure in spotting a surface, and scraping it. Divide the group into pairs, and assign each pair of trainees to spotting and scraping-in a babbitted bearing. Transfer each pair of trainees to work on the bearing and the shaft that other trainees have previously fitted. Have each pair of trainees inspect the bearing and shaft that were previously fitted and found to be correct. The top half of the bearing should be spotted and "scraped in".

b. Transfer each pair of trainees once more to work on a bearing assembly. The work should be inspected by the trainees as before, and if correct, the cap should be bolted to the bearing with the shaft in place. Then try the shaft to see if it will revolve in the bearing. If the fit is too tight, shim stock will have to be used to eliminate the binding. If the shaft is too loose after the cap is bolted down snugly, the joint between the bearing and the cap will have to be dressed off until the correct fit is obtained.

c. Fit a shaft to a bearing following the same procedure as in step 3" with this exception: Use brass or iron bearings instead of babbitted bearings.

20. Trammels

SUGGESTIONS:

a. Place a large sheet of black iron or other available sheet metal on the bench. The sheet should be supported uniformly throughout. Have the trainee lay off and scribe a center line from end to end of the sheet. Have the trainees work in pairs. Two inches from the edge of the sheet and at right angles to the center line, scribe a second line, and on this second line lay out and scribe an equilateral triangle. Check the work of the trainees from point to point, and have the trainee check the job.

b. Assign a sheet of metal to each pair of trainees. Have the trainee set the trammels and lay out a rectangle 18" on a side. Show them how to prove their work by using the trammels.

c. Assign each trainee to a separate job. The instructor will furnish each man with a sketch of geometrical design (no two designs should be alike). The sketches should have the outline of the shape and actual dimensions required. When completed, each assignment should be passed along to the next man for him to check for accuracy.

21. Allen wrenches

SUGGESTIONS:

a. Have ready a 1¼" shaft with a number of tapered pins driven through at intervals of ⅝". See Fig. 8. At right angles to the center line of the tapered pin, have holes drilled to take a ¼" Allen set screw. Several of these shafts should be available.

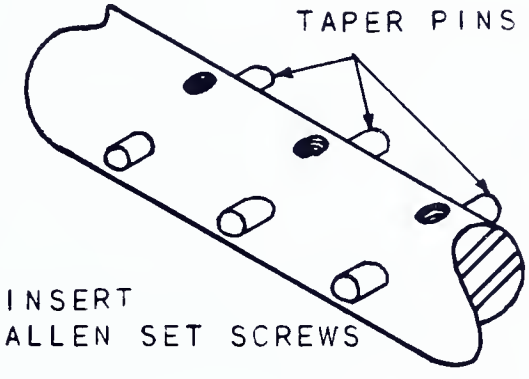


FIG. 8 — *Taper Pins to be Secured with Allen Set Screws.*

b. Have the trainees insert the taper pins in the correct holes and snug them home lightly. Insert Allen set screws; tighten them up with the Allen wrench. Have the trainees drive the taper pin out while the Allen set screws are set against the pin. (Only light blows should be used in order to demonstrate the efficiency of the Allen set screw when used in this connection.)

Other demonstrations may be arranged and assignments worked out with available equipment which will allow the trainees to obtain a wide variety of work experiences.

22. Straightedge

SUGGESTIONS:

a. An exhibit of a small, cast-iron straightedge. Point out that the straightedge is finish-ground on all the working surfaces.

b. Explain that rough handling of the straightedge will result in raising small bumps or pimples on the finished surfaces and that when this happens these uneven bumps will not permit the straightedge to rest evenly on the surface that is being checked.

c. Compare the characteristics of a steel straightedge and a cast-iron straightedge.

PART II

OUTSIDE MACHINIST TRAINING
ADVANCED WORK AND MAINTENANCE

Part II

TRAINING FOR ADVANCED SHIPYARD OUTSIDE MACHINISTS

ıere is always an opportunity for advancement if the beginner is ambitious. kmen who are capable and willing to assume responsibilities are needed as ers. Such men may be selected and trained in advanced phases of the work to are them to work in groups under the supervision of a leader.

here new employees have had some previous experience in shipyard practice, nced training may be given immediately. Workmen who are employed in less ed shipyard occupations and show superior ability may be assigned to outside ıinist groups. The instructors responsible for the training of the above men- d groups may determine what level of knowledge and skill has been attained ıe individual, and present instruction covered in Part I, "Training for Begin- Outside Machinist". Such instruction may be given *prior* to the more advanced : or it may be given, as circumstances warrant, with the advanced work. The ɔrtance of providing necessary training in the fundamentals must be constantly] in mind.

ENERAL COMMENTS CONCERNING ADVANCED INSTRUCTION FOR OUTSIDE MACHINISTS

Prerequisites

general, the statement of "objectives" indicates the ratings or classifications of ɔns who probably will be given advanced instruction. Because the specifica- for these work classifications may vary considerably from yard to yard, the ific admission requirements should be determined in conference with responsible ɔns in the yard for which training is being given.

Objectives of Advanced Training for Outside Machinists

To up-grade outside machinist's helpers of the laborer level so that they may be capable of performing the duties of second-class outside machinists.

To up-grade second-class outside machinists so that they may be capable of performing the duties of first-class outside machinists.

It is highly desirable that each of the above objectives be considered separately. Classes should be organized for each group. It is further desirable that the groups be broken down into specific block-training procedures, that

is, training for certain work should be given to a selected group. Fo ample, training in chock fitting may be given to men who have shown dency to perform this job well. Training in aligning pump and motor may be given to another selected group. These selections should be made careful consideration as to what section of the shipyard the trainee w assigned upon the completion of the course. Advancing from outsid chinist's helper to second-class machinist requires considerable yard e ence in addition to the instruction given in Parts I and II.

Tools to be Furnished by the Trainee for School Purposes

1. 6″ steel scale
2. 6′ steel tape
3. 1—¾-lb. machinist's hammer
4. Pocketknife
5. Lead pencil
6. 6″ spring dividers
7. 6″ inside calipers
8. 6″ outside calipers
9. 6′ folding rule
10. Set of open-end wrenches
11. Center punch
12. Prick punch
13. 12″ combination squarc
14. Thickness gauge 1.005″ to 1.05″
15. 1″ outside micrometers
16. 6″ side-cutting pliers
17. Plumb bob and line
18. 1″ flat cold chisel
19. Scriber

Tools to be Furnished by the School

1. Portable grinder
2. Necessary files
3. Stillson wrench
4. Packing hooks
5. Valve-seat remover
6. Socket wrenches
7. Tap die sets
8. Small leveling jacks
9. Iron straightedges
10. 50′ steel tape
11. Trammels with beam
12. Adjustable wrenches ¼″ to 1″
13. 24″ level
14. Assorted C-clamps
15. Drilling machine
16. Necessary reamers
17. Necessary drills
18. Dial indicator
19. Spoon scraper
20. Flat scraper
21. Hand scraper
22. 3-cornered scraper
23. Turn scraper
24. 3′ pinch bar
25. 20-lb. maul
26. Taper-pin reamers
27. Stud drivers
28. Declivity board
29. Mock-up bearing and journal

Supplies

1. Mock-up foundation
2. Steel plates of various thicknesses, widths, and lengths
3. Assortment of cast-iron chocks in the rough
4. Chock sheets
5. Blue chalk
6. Marking paint
7. Gasket material
8. Thread dope
9. Pipefitting
10. Lamp wicking
11. Stuffing-box packing
12. Red-lead putty
13. Steam packing
14. Grinding compound

Mock-ups in valve seats, valve disc
Template wood
Soapstone pencils
Bolts and nuts as required
Flange couplings
Steel wedges
Side jacks
Set screws
Shims
24. Prussian blue
25. Lead wires
26. Shim stock
27. Cleaning fluid
28. Cup grease
29. Lead cards
30. Cleaning rags
31. Wire-inserted sheet rubber packing

SUGGESTED OUTLINE OF INSTRUCTION FOR ADVANCED TRAINING IN OUTSIDE MACHINIST

Time required: Approximately 129 to 191 hours of instruction, including shop talks, demonstrations, and shop practice (practical work by trainee.)

1. How to use and care for a portable grinder.
2. How to fit various types of chocks.
3. Where to use various gasket materials and thread dope.
4. How to make a full face gasket.
5. How to make a ring gasket for a standard six-inch flange joint.
6. How to cut a dovetail gasket.
7. How to pack a stuffing box.
8. How to make a watertight joint.
9. How to overhaul valves.
10. How to check and grind valve seats.
11. How to set a valve.
12. How to use a declivity board and level.
13. How to strike a chalk line under various circumstances.
14. How to select, set, and fit a deck stand.
15. How to install a pump.
16. How to align pumps, motors, and couplings.
17. How to overhaul a steam pump.
18. How to spot and scrape bearings.
19. How to install operating rods correctly.
20. How to fit a sea-chest strainer plate.
21. How to install valves.
22. How to install overboard spools.

TOPIC NO. 23

I. Topic — Using a Portable Grinder.

II. Tools and Equipment

1. Portable grinder
2. Air supply
3. C-clamps
4. Bench
5. Bench vise

Supplies

Mock-up foundation or actual foundation (boiler plate)

Several pieces of ½" boiler plate, approximately 4" 10", or larger.

Assortment of cast-iron chocks in the rough.

III. Reference — *Shipyard Outside Machinist*, page 91.

Instructional Aids

Specimens of ground surfaces (chocks and foundations).

IV. Teaching Hints:

A. Safety:

1. Give a brief lecture on the safe use of a portable grinder. Stress importance of using the air valve correctly.
2. Stress the importance of wearing goggles while operating the portable grinder or while working near another mechanic who is using a portable grinder.

B. Information to be presented:

1. The lesson on "Using a Portable Grinder" on pages 91 and 92 of the *Shipyard Outside Machinist* manual.
2. Various jobs on which a portable grinder will most likely be used in Shipyard Outside Machinist practice.
3. How to care for a portable grinder correctly.

C. Demonstration by the instructor:

1. How to hold a portable grinder correctly while grinding.
2. How to clamp a piece of steel plate in the vise and grind the edge straight.
3. How to grind level the corner location on a foundation or mockup foundation.
4. How to check the work with a scale or straightedge.

D. Student practice:

1. Have the trainee handle the portable grinder and manipulate the control.
2. Have the trainee grind the edge of a piece of plate straight and true.
3. Have the trainee grind level a spot 4″ square on a mock-up foundation.
4. Have trainees compare their work with the work of other trainees.

Assignment:

1. Have the trainee answer the questions on page 92 of the *Shipyard Outside Machinist* manual.
2. Have the trainees check for accuracy pieces of work that have been previously prepared and numbered. (The trainee is instructed to reject the pieces which are not level.)

Time — 9 to 12 hours.

TOPIC NO. 24

I. Topic — Fitting Chocks.

II. Tools and Equipment

1. Files: 12″ bastard flat, 12″ flat mill
2. 6″ scale
3. 8″ inside calipers
4. Portable grinder
5. 1 — ¾-pound hammer
6. 6″ outside calipers
7. Thickness gauge
8. Adjustable foundation and base mock-up fixture for chock-fitting pra See Fig. 9.
9. Bench
10. Open-end wrench to fit fixture cap screws

Supplies

Chock sheet
Blue chalk
Marking pai

III. Reference — *Shipyard Outside Machinist*, page 92.

Instructional Aids:

A. A pump or motor unit fitted with chock and bolted to foundation.

B. A chock which has been fitted.

IV. Teaching Hints:

A. Safety:

1. Review safety practices for using a portable grinder, Topic No. 23.
2. Be sure of firm footing.
3. Many cables, hose lines, and miscellaneous equipment are always present around the job. Avoid tripping or falling over these obstructions.

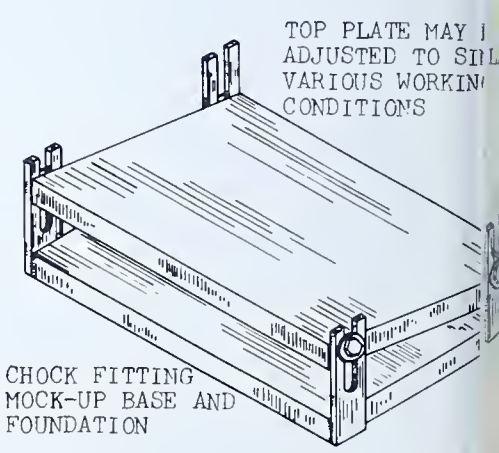


Fig. 9 — *Mock-up for Chock Fittin*

B. Information to be presented:

1. The information given in Fig. 127, page 92 of the *Shipyard Outside Machinist* manual.
2. The reason for a better chock fit when the opening is tapered ite of being parallel.
3. The fact that a chock must never be ground on the pedestal side.

4. The fact that worn-out files are useless for filing chocks.
5. The fact that files can be made to last longer by taking full strokes and by using the correct files for work on various metals.
6. The correct manner in which chalk should be used when fitting chocks.
7. How the position of the chock may be identified by using marking paint.

C. Demonstrations by the instructor:

1. How the inside calipers are used to measure for the chock thickness. Have ready a unit and a foundation or a mock-up to show this.
2. How the chock sheet is filled in for future identification of the chock.
3. How to stand to file efficiently.
4. Have ready a unit and a foundation with fitted chocks. Have trainees check with the thickness gauge. Point out the close fit required. Check a correctly fitted chock with the thickness gauge.

D. Student practice:

Divide the class into pairs and assign to each pair a chock-fitting location.

1. While one trainee does the measuring, have the second trainee fill in the chock sheet.
2. Reverse the positions of the trainees and have the measurements checked.
3. Check with each pair of trainees for accuracy. (As the chocks must be machined to the dimensions given on the chock sheet, the instructor should have ready a set of chocks on which to work while the measured chocks are being machined.)

   (Arrange several practice chock-fitting fixtures and chocks, and assign a fixture to two trainees.)
4. Have the trainees fit the chocks to the surfaces presented by the fixtures. (The trainees may alternate as the fitting proceeds.)
5. When the chocks are fitted, have the trainees shift to the next station and check the work of other trainees.

The instructor will assist the trainees as they work. Spend only a short time with each trainee, but keep circulating. Interest must be kept alive.

V. Assignment:

1. Have trainees answer questions on page 96 of the *Shipyard Ou Machinist* manual.

   (Select the trainees who have done the job of chock fitting in a si factory manner, i.e., level, closefitting, and to size.)

2. Assign these trainees to a special location and give them each a c to fit. Keep a record of each trainee's time.

   (Do not assign a trainee to a job until he has proved his ability practice piece. When he has completed his job, direct the attention o entire group to it.)

VI. Time — 12 to 15 hours.

TOPIC NO. 25

I. Topic — Using Gasket Materials and Thread Dope.

II. Tools and Equipment

1. Stillson wrenches
2. Open-end wrenches

Supplies

Samples of gasket materials and thread dope. Pipe and fittings.

III. Reference — *Shipyard Outside Machinist*, page 97.
Gasket Material Catalogs.

Instructional Aids:

A. Flexitallic Gasket Co., Camden, N. J.

B. Crane Catalog No. 52.
Crane Co., 836 S. Michigan Ave., Chicago, Ill.

C. Wall charts (if available).

D. Specimens of gasket material that have been in service (good and bad).

IV. Teaching Hints:

A. Safety:

1. Use a sharp knife when cutting gaskets; dull knives are dangerous.
2. The position of the mechanic when cutting should be such that no injury can result if the knife slips.
3. Avoid the possibility of infection when working with white lead. It is poisonous. Scratches, open wounds, and cuts should be protected.

B. Information to be presented:

1. The lesson in the *Shipyard Outside Machinist* manual, beginning on page 97.
2. Cases on record where faulty gasket material or wrong use of thread dope has caused trouble.

C. Demonstration by the instructor:

Have ready the necessary equipment and material to show the results of the practice mentioned on Page 98 of the *Shipyard Outside Machinist* manual under the heading: "Suggestions in Connection with the Use of Gaskets".

1. How to install a ring gasket between cast-iron flanges, so that the flange will not crack.

2. How to install a gasket between two thin flanges so that they will n "dish".

3. How to install a gasket in brass flanged joints so that the brass flang will not "dish".

4. How to install a gasket where the flanges are exposed to the weather, on deck, so that rust will not form in the space from gasket edge to flan edge and cause the flange to become deeply pitted.

5. How to install a gasket where studs are used if there is any pressure the back end of the studs, for example, on watertight bulkheads.

6. How to use ring joints extensively in all places not exempted in t foregoing. (They tighten more readily, hold tight better than full join and eliminate the danger of leaks around the bolts.)

D. Student praetice:

1. Have the trainees examine specimens of gasket material. (Have materi ready for making small quantities of thread dope, red-lead putty, litha and glycerine, key paste, white lead, and smooth-on.

2. Have the trainees mix and use the various materials for thread dope a other purposes.

V. Assignment:

1. Have the trainees answer the questions on page 99 and 100 of the *Sh yard Outside Machinist* manual. (Have ready several valves of varic sizes and types. Direct the trainees to apply the necessary thread d and assemble the valves.)

2. (Have ready several valves of various sizes and types.) Direct the train how to remove the bonnets and how to clean the threads on the studs a in the nuts. When the threads are ready, have the trainee install gas and thread dope and reassemble the bonnet on the valve body.

VI. Time — 3 to 5 hours.

TOPIC NO. 26

Topic — Making Gaskets: Full Face Gasket.
Ring Gasket
Dovetail Gasket

Tools and Equipment:

1. Machinist's hammer
2. Pocketknife
3. Outside calipers
4. 6″ scale
5. Dividers
6. Pencil

Supplies

Flange
Gasket material
Standard gasket

Reference — *Shipyard Outside Machinist*, pages 100, 101, and 102.

Instructional Aids:

Specimens of gaskets mentioned in the *Shipyard Outside Machinist* manual.

Teaching Hints:

A. Safety:

1. Point out how injuries which may result in infection can be caused by careless handling of the tools.
2. Explain what to do to prevent infection in case of cuts or bruises.

B. Information to be presented:

1. The instruction sheets on making and cutting gaskets.
2. The several applications of gaskets and the results of poorly fitting and incorrectly installed gaskets.

C. Demonstration by the instructor:

1. How to measure the inside and outside diamcters of gaskets.
2. How to cut bolt holes through with a hammer, using a hole in a flange to cut to size.
3. How to cut a ring gasket to size with a knife (on previously scribed lines).
4. How to lay out a dovetail on a standard size of gasket.

5. (Have ready a suitable valve.) How a bonnet may be lifted and a d
tail gasket installed without disassembling the valve.

D. Student practice:

1. (Divide the group into pairs.) Have the trainees lay out gaskets t
certain previously designated locations. (Cardboard may be use
place of gasket material if regular gasket material is not available.)

2. Have the trainees cut holes in gaskets to fit certain flanges that are
pared for this purpose.

V. Assignment:

1. (Have prepared a number of units to which gaskets are to be fi
Divide the group into pairs and assign a gasket job to each pair of trai
(When the gaskets are cut and ready for installation, check the w

2. Have the trainee inspect the work of other trainees.

3. Have the trainees install the gasket, using gasket dope according t
structions.

4. Have the trainees answer questions on pages 99, 100, 101, and 102 o
Shipyard Outside Machinist manual.

VI. Time — 6 to 9 hours.

TOPIC NO. 27

. Topic — Making and Installing a Grommet.

. Tools and Equipment	Supplies
1. Rule	Ball of lamp wicking
2. Pocketknife	Stock grommets

. Reference — *Shipyard Outside Machinist*, page 104.

Instructional Aids

A. Specimens of handmade grommets.

B. Specimens of grommets that have been in use.

. Teaching Hints:

A. Information to be presented:

1. The reasons for using grommets.
2. Why a grommet serves the purpose of making a tight job better than other material.
3. Objections to "lumps" in the gasket.

B. Demonstration by the instructor:

1. How to cut off a piece of wicking and proceed to make a grommet. (Perform the operations slowly enough for the trainee to see clearly what is done.)
2. How to install a grommet over a stud.
3. The handmade grommet in comparison with a ready-made grommet.

C. Student practice:

1. Have each trainee cut off a piece of wicking to make a certain size of gasket.
2. Make up a gasket slowly, and have the trainees, in unison, follow the same procedure.
3. Have the trainees inspect the work done by their fellow trainees.
4. Have the group unwind the gasket coil and repeat making the grommet. At the same time criticise the movements of each trainee.

Assignment:

1. Assign one grommet job to each pair of trainees. (Have ready a number of jobs that require grommets.)
2. Have the trainees inspect the work done by others.
3. Have the trainees answer the questions in the *Shipyard Outside Machinist* manual, page 105.

Time — 3 to 5 hours.

TOPIC NO. 28

I. Topic — Packing a Stuffing Box.

II. Tools and Equipment

1. Open-end wrench
2. Pocketknife
3. Packing hook
4. Stuffing boxes to be packed

Supplies

Packing

III. Reference — *Shipyard Outside Machinist,* page 105.

Instructional Aids

A. Stuffing box and gland with packing installed.
(Sawed in half to show section.)

B. Charts or blueprints showing locations of various types of stuffing boxes.

C. Trade catalogs showing valves and stuffing boxes.

1. Catalog No. 76, Jenkins Valves, Jenkins Bros., Inc., 80 White St., N York, N. Y.

2. Catalog No. 11, The Wm. Powell Co., Cincinnati, Ohio.

3. Walworth Catalog No. 42, Walworth Co., Inc., 60 E. 42nd St., New Yo, N. Y.

IV. Teaching Hints:

A. Safety:

Point out precautions the trainee should observe now and when on the j. (Avoid pinched fingers, wounds from packing hook or knife, abrasi caused by the slipping of wrenches that are not the correct size.)

B. Information to be presented:

1. The purpose of stuffing box, gland, and packing.

2. The locations of stuffing boxes.

3. Why the individual packing rings do not butt on the ends.

4. Why joints are staggered in packing-ring sets.

5. The damage caused by old and hardened packing.

C. Demonstration by the instructor:

1. How the old packing in a stuffing box fails to make a tight joint.
   (Select a stuffing box in which the packing has become hardened with age.)
2. How to extract the old packing from the stuffing box.
3. How to clean the stuffing box thoroughly. (Have the trainees examine the job carefully.)
4. How to pack the stuffing box.
5. How to place the gland and pull the nuts down correctly.
   (Stress this point.)

D. Student practice:

1. (Have ready a number of valves or mock-ups which are equipped with stuffing boxes.) Have the trainees work in pairs and extract the old packing from the stuffing boxes.
2. Have the students inspect their own job thoroughly.
3. Have the trainees select and prepare packing to stuff the boxes.
4. Have each pair of trainees present the job to the instructor for approval when the first two packing rings are ready.
5. If approved, have the trainees finish stuffing the boxes.
6. Have the trainees place the gland and draw down tightly.
7. Call for comments and suggestions from the group. Be sure the trainee understands thoroughly the reason for every move.

ASSIGNMENT:

1. (Have ready a number of jobs.) Assign a stuffing-box packing job to each pair of trainees.
   (Every man is "on his own", and the instructor will give no instruction at this time. He will stop a trainee at once if he is proceeding incorrectly. This should be understood before the work begins.)
2. Have trainees answer questions on pages 107 and 108 of the *Shipyard Outside Machinist* manual.
   (The instructor will review the lesson and answer questions.)

TIME — 3 to 6 hours.

TOPIC NO. 29

I. Topic — Making a Watertight Joint.

II. Tools and Equipment

1. 5/8" end wrenches

Supplies

5/8" cut washers
5/8" hexagon nuts
Lamp wicking
5/8" stock grommets
3" full face gaskets
Red-lead putty

III. Reference — *Shipyard Outside Machinist,* page 108.

Instructional Aids

A. Specimen of a watertight joint.

B. Blueprint of installation where a watertight joint is used.

IV. Teaching Hints:

A. Information to be presented:

1. Explain thoroughly the purpose of a watertight joint.
2. Point out specific locations of units which require watertight joints.

B. Demonstration by the instructor:

1. (Have ready a tank or mock-up.) How to install a fitting so as to mak a watertight joint.
2. How to show that the job is watertight. Fill the tank with water.

C. Student practice:

1. (Have ready several previously prepared jobs which require watertight joints.) Assign a watertight-joint job to trainees working in pairs.
2. Have the trainees test their jobs with water.
3. Where jobs show leaks have them pulled down and reworked.

V. Assignment:

1. Have the trainee make a watertight joint on a specially prepared job. (An actual job should be donc according to plan and specification if possible.)
2. Review the lesson, and have the trainees answer questions on pages 108 and 109 of the *Shipyard Outside Machinist* manual.

VI. Time — 3 to 5 hours.

TOPIC NO. 30

I. Topic — Overhauling a Valve.

II. Tools and Equipment

1. Machinist's personal tool kit.

Supplies

Globe valves
Gasket material
Steam packing
Grinding compound

III. Reference — *Shipyard Outside Machinist*, page 109.

Instructional Aids

A. Globe-valve cross section (actual valve).

B. Gate-valve cross section (actual valve).

C. Wall charts or blueprints of valves (local source).

D. Catalogs of valves showing installations. (See source below.)

1. William Powell Co., Cincinnati, Ohio.
2. Jenkius Valves, Jenkins Bros., Inc., N. Y., N. Y.

Teaching Hints:

A. Safety:

1. Lift and handle valves safely.
2. Use necessary precautions to avoid injuring another workman.
3. Get sufficient help to avoid personal strain.

B. Information to be presented:

1. The construction of a globe valve in comparison with the construction of a gate valve.
2. The procedure for removing a valve from a pipe line.
3. The valve-seat defects that may develop and how to identify them.
4. The process of refacing a valve; flat seat; bevel seat.
5. The overhauling procedure from page 110 to page 112 inclusive, *Shipyard Outside Machinist* manual.

(Encourage the trainees to ask questions. Discuss these questions with the group.)

C. Demonstration by the instructor:

(Have ready globe valves for overhauling.)

1. How to dismantle a valve. (Have trainees assist.)
2. How to identify scores, pits, and other imperfections in the valve e and disc.
3. How to test the valve seat.
4. How to remove a valve seat. (Plain type and screw type.)
5. How to back off the valve stem so the disc will clear the seat whe th valve is reassembled.
6. How to use a valve-seat refacing tool.
7. How to reassemble the valve.

D. Student practice:

Have the trainees work on several valves which are to be dismantle i spected, repaired, and reassembled.

(The instructor will criticize the trainee's work and assist with u gestions. The trainee should be drilled until he is proficient in t i down and reassembling valves.)

V. Assignment:

1. Each trainee is assigned a job of tearing down and reassembling a val .
2. Have the trainee answer the question on page 12 of the *Shipyard Ou i Machinist* manual.

VI. Time — 3 to 6 hours.

TOPIC NO. 31

Topic — Grinding Valve Seats.

Tools and Equipment

1. Valve-Seat Remover (For pressed-in valves; for screwed-in valves)
2. Machinist's personal tools

Supplies

Several used valves (globe and gate)
Gasket material
Stem packing
Grinding compound
Mock-ups of valve seats and valve discs.

Reference — *Shipyard Outside Machinist,* page 113.

Instructional Aids

A. Globe-valve cross section (actual valve).

B. Gate-valve cross section (actual valve).

C. Valve seats (pressed-in and screwed-in types).

D. Glove valve without valve seat but having recess ready to receive the valve seat (pressed-in type; screwed-in type).

Teaching Hints:

A. Safety:

1. Lift and handle valves carefully.
2. Avoid wiping valve-grinding compound on face, especially near the eyes.
3. Get sufficient help to avoid personal strain.

B. Information to be presented:

1. The mechanics of sealing a valve seat.
2. How the valve disc "floats" on the stem, and the reasons for so constructing the valve stem.
3. How to measure a valve for size.
4. The necessity for having the bonnet fit to the valve flange so that the valve stem will be carried at right angles to the face of the flange.
5. The direction of flow, and why the pressure tends to "lift" the valve disc.
6. Why the gate valve can not be seated by "grinding in".
7. How the "ridges" or "rings" are caused by wear, and why the valve will not hold against pressure under these conditions.
8. Why valve seats that are badly worn are trued by machining before being "ground in".

C. Demonstration by the instructor:
(Have ready a worn valve to be reseated)

1. How to disassemble for the purpose of making repairs.
2. How a new valve (cross section) compares with the old one.
3. How the valve seat is removed with the special tool.
4. How to replace the old seat with the new one.
5. How to remove the valve disc and check it for trueness and depth of sc e.
6. When to lay it aside to be trued up in the machine shop.
7. How to install the new valve disc and fasten it firmly to the stem.
8. How to "grind in" the valve seat to the valve disc.
(Repeat the operations and call on the trainee for any questions.)
9. Clean the compound from the valve seat and valve disc thoroughly.
10. How to check the valve seat with pencil marks to show proper seat g.
11. How to reassemble the valve disc, place the bonnet, and reassemble ie valve. (Take pains to have trainee understand every move.)

D. Student practice:

1. Divide the group into pairs, and assign a valve for reseating to ch pair of trainees.
2. Have the trainees follow the steps in the instructor's demonstration.
3. Drill the trainees in every manipulative operation until they are famia with their job.
4. Have trainees inspect work of other trainees.

V. Assignment:

1. Have the trainees answer the questions on pages 116 and 117 of the *Shipyrd Outside Machinist* manual.
2. Have each trainee disassemble a globe valve, reseat the valve, and reassemble the valve.
3. The instructor will check closely on the work of each trainee to see that he s:
   1. Using the tools correctly.
   2. Following instructions in proper sequence.
   3. Doing a workmanlike job.
   (The work should be proved under pressure if means can be made availal.)

VI. Time — 3 to 6 hours.

TOPIC NO. 32

Topic — Setting a Valve.

Tools and Equipment	Supplies
1. End wrenches	Mock-up with pipe flanges in place to receive the valve. See Fig. 14.
2. Socket wrenches	
3. Machinist's hammer	Suitable valve to be installed on the pipe flange.
4. Protractor	Necessary bolts, nuts, and studs.
5. 12″ scale	Gasket material
6. Declivity board	Piece of boiler plate 4′ x 6′ on which to lay out a valve setting.

Reference — *Shipyard Outside Machinist,* page 117.

Instructional Aids

A. Globe valve installed at an angle.

B. Globe valve installed vertically.

C. Wall charts of globe valve installed at various angles (local source).

D. Blueprints which give valve settings.

E. Cardboard models of globe valves
Jenkins Bros., 80 White Street, New York, N. Y.

Teaching Hints:

A. Safety:

1. Lift and handle valves carefully.
2. Get sufficient help to avoid personal strain.
3. Avoid abrasions and cuts on the hands from handling materials and equipment.

B. Information to be presented:

1. Why valves sometimes have to be set at an angle.
2. The methods used in selecting the correct pair of bolt holes to obtain the angle for valve setting.
3. How to use a declivity board when setting a valve vertically fore-and-aft. (When the ship is on the ways).
4. Why a declivity board is not used in setting a valve vertically athwartships or when setting a valve at an angle athwartships.

   Select from the wall chart or blueprints some specific valve-setting layout, and explain that the pipe flange to which the valve is to be connected has previously been set in such a manner that the bolt holes or studs will allow the valve to be attached at the correct angle.

C. Demonstration by the instructor:

1. How to lay out on the boiler plate, previously prepared for this purpo the valve-center lines and the angle at which the valve is to be set.
2. How to set on a bench or table a valve which is to be installed and blo it over at an approximate required angle setting.
3. How to set the protractor at an angle specified on the blueprint and che the position of the valve as it lies on the bench. (This is done for illu trative purposes only.)
4. How the position of the bolt holes in the valve-body flange correspon with the location of the bolt holes or studs in the pipe flange to whi the valve is to be attached.

   Repeat the layout and blocking up of a valve with one or two other valv so that the trainee may become familiar with the preliminary steps preparing to set a valve.

D. Student practice:

1. Select a pair of trainees from the group and have them outline the pr cedure for setting a valve in a vertical position on the pipe flange whi has been previously secured to the dummy bulkhead.
2. Have the trainees repeat the steps which they will take to install the val until the proposed procedure has been firmly established in the min of the group.
3. Have the trainees install a valve on the pipe flange according to specifi tions. (This operation should be repeated until the trainee can do t work without mistakes.)
4. Assign the same job to other trainees and have them perform the sa operations until they are familiar with the procedure.
   (Give every trainee the same opportunity to practice installing a val in the same manner.)

V. Assignment:

1. Have the trainee answer the questions on pages 118 and 119 of the *Shipya Outside Machinist* manual.

   (Have available a number of mock-ups on which valves are to be install at various angles.)

   Assign installations to pairs of trainees. (All work is to be performed a cording to instructions given on the blueprint or on especially prepar instruction sheets. The instructor will check the accuracy and workmansh of each pair of trainees.)
2. Have the trainees inspect the work of other trainees.

VI. Time — 3 to 6 hours.

TOPIC NO. 33

TOPIC — Using a Declivity Board.

TOOLS AND EQUIPMENT

1. Small wedges (wood and metal)
2. Leveling jacks (small)
3. Declivity board
4. Level
5. Machinist's hammer
6. 6″ scale
7. Air grinder
8. Straightedge
9. Mock-up ship's deck
10. Mock-up foundation
11. Mock-up unit to be installed
12. Knife
13. 6′ steel tape

SUPPLIES

Chalk

Template wood

REFERENCE — *Shipyard Outside Machinist,* page 119.

INSTRUCTIONAL AIDS

A. Blueprint of unit installation.

B. Wall charts of installation set on a declivity.

TEACHING HINTS:

A. Safety:

1. Work carefully for self-protection and for the protection of others.
2. Keep the floor clear of tools and miscellaneous materials.

B. Information to be presented:

1. Definition of declivity.
   (Give examples of declivity and tell why a ship is built on a shipway having declivity.)

2. How to place a declivity board and level.
3. How to use a declivity board and level in relation to sheer and camb.

C. Demonstration by the instructor:

1. How to determine declivity.
(Make a sketch on the blackboard to show ground, keel blocks, base le, bulkheads, decks, etc.)
2. How to make a declivity board of 27″ and 42″ lengths using templ wood, knife, and 6′ tape.
3. How the location pads for the base of a unit are checked and ground lel to receive the unit base.
4. How to grind the pad tops.
5. How the declivity board and level are used to check the grinding.

D. Student practice:

1. Have trainees work in pairs and check declivity of a plate, or mock-p, at different degrees of declivity.
2. Have trainees make a declivity board of 25″ and 40″ lengths.

V. Assignment:

1. Have the trainees answer the questions on page 122 of the *Shipyard Outfi Machinist* manual.
2. Select two trainees and have them set up the mock-up unit on the mock-up ship's deck, using the declivity board and level.
3. Repeat item 2 until all of the trainees are familiar with the procedure.
4. Have trainees lay out template wood to various, given, declivity-board spci fications.

VI. Time — 3 to 5 hours.

TOPIC NO. 34

TOPIC — Striking a Chalk Line.

TOOLS AND EQUIPMENT	SUPPLIES
1. 6″ steel tape	Chalk
2. Machinist's hammer	Soapstone pencil
3. Center punch	
4. Combination squares or 6″ try squares	
5. Chalk line	
6. Cold chisel	
7. Trammels with long beam	

REFERENCE: — *Shipyard Outside Machinist*, page 122.

INSTRUCTIONAL AIDS

A. Wall chart of chalk lines struck at various intersections and parallel with center lines.

B. Chalk line previously struck (finely painted line) on floor of the classroom.

TEACHING HINTS:

A. Safety:

1. Be careful to avoid injuries caused by contacts with miscellaneous materials lying about on the deck or floor.
2. Be careful to avoid raising the head or standing up quickly before looking to make sure there are no obstructions.

B. Information to be presented:

1. Colors of chalk most suitable to use.
2. Size and kind of line to use.

C. Demonstration by the instructor:

1. How to hold a chalk line.
2. How to apply chalk to the line.
3. How to "position" the line.

4. How to snap the line.

5. How to strike a line on a horizontal surface.

6. How to strike a line on a vertical surface.

7. How to strike a line across an uneven surface.

D. Student practice:

Have trainees practice striking chalk lines.
(Trainees should work in groups of three, interchanging their positions fr n time to time.)

V. Assignment:

1. Have the trainees answer the questions on pages 124 and 125 of the *Shipy d Outside Machinist* manual.
(Divide the class into groups of three. Have ready previously prepa d sheets or blueprints of layouts that are to be reproduced by striking ch k lines on a convenient surface, such as a floor, a wall, the blackboard, or ot r selected surfaces.)

2. Assign three blueprints to each group, and have the group strike chalk li s according to the center lines given on the blueprints.

V. Time — 6 to 9 hours.

TOPIC NO. 35

TOPIC — Setting and Fitting a Deck Stand.

TOOLS AND EQUIPMENT

1. Portable air drill
2. Chalk line
3. Fifty-foot steel tape
4. Center punch
5. Machinist's hammer
6. 10″ dividers
7. Open-end or adjustable wrench — ¼″ to 1″ U.S.S.
8. Level
9. Declivity board

SUPPLIES

Marking paint

Soapstone pencil

Blue or white chalk

Mock-up of ship's deck

Several deck stands to be fitted to deck

REFERENCE — *Shipyard Outside Machinist*, page 125.

INSTRUCTIONAL AIDS

A. Wall chart of deck stand set in position and welded to the deck. (Have chart made to suit locality.)

B. Blueprints of deck-stand installations.

TEACHING HINTS:

A. Safety:

1. Be careful to avoid injuries caused by contact with miscellaneous material and equipment on the classroom floor or on the ship's deck.
2. Watch for the movements of other workmen to avoid causing accidents.

B. Information to be presented:

1. Locations of deck stands.
2. Purpose of deck stands.
3. How a deck-stand location is found on a blueprint.
4. How the deck-stand location is found on the deck.
5. Steps to follow in laying out location for and installing a deck stand.

C. Demonstration by the instructor:

1. How a deck-stand center is established.
2. How a deck stand is wedged level with the deck.
3. How the deck line is scribed on the base of a deck stand in preparation for machining off to fit the deck.
4. How to mark identification symbols on the deck stand and on the deck.
5. How to set a machined-base deck stand in the correct location and check for alignment.
6. How welding procedure affects allowance for machining.
7. How the pointer setting is accomplished.
8. How to install operating rods in connection with installing a deck stand.

D. Student practice:

1. Have the trainees work from a blueprint and lay out the location of a deck stand.
2. Have the trainees level and wedge a deck stand.
3. Have the trainees scribe a line on the base of the deck stand for machining.
4. Have the trainees work on previously prepared deck stands and set pointers.

V. Assignment:

1. Have trainees answer questions on page 128 of the *Shipyard Outside Machinist* manual.
2. Assign a job of setting up and scribing the base of a deck stand on a make-up ship deck.

VI. Time — 6 to 9 hours.

TOPIC NO. 36

TOPIC — Installing a Pump.

TOOLS AND EQUIPMENT	SUPPLIES
1. Center punch	Chalk
2. Scale	Chocks
3. Hammer	Bolts
4. Dividers	Mock-up foundation
5. Chalk line	Marking paint
6. Drilling machine	
7. Drills	
8. Reamer	
9. Files	
10. Chock sheets	
11. Air grinder	
12. Straightedge	
13. Inside calipers	
14. Outside calipers	
15. C-clamps	

REFERENCE — *Shipyard Outside Machinist*, page 128.

INSTRUCTIONAL AIDS

A. Wall chart showing pump installed.

B. Blueprints of pump installations.

C. Horizontal duplex steam pump on the floor.

TEACHING HINTS:

A. Safety:

1. Be careful to avoid injuries caused by contact with miscellaneous material and equipment on the classroom floor or on the ship's deck.

2. Watch for the movements of other workmen to avoid causing accidents.

B. Information to be presented:

1. Location of pumps.
2. Types of pumps.
3. Purposes of pumps.
4. How to check the blueprint for the correct location of the pu foundation.
5. How to prepare the foundation for the pump.
6. How to level the pump correctly.
7. A review of "Fitting Chocks", page 92, *Shipyard Outside Machinist*

C. Demonstration by the instructor:

1. How to locate the position of the pump on the foundation.
2. How to level the pump on the foundation.
3. How to clamp the pump in position.
4. How to measure and record chock sizes.
5. How to mark chock locations.
   (Chocks may be sent to machine shop for machining, and they ma fitted during the next period if there is available time. The work o ting the chocks at this time may be a good review of the chock fi done under Topic No. 24.)

D. Student practice:

1. Have the trainees work in small groups, and have each group lay out a blueprint the position on the foundation for a pump.
2. Have the group study the blueprint and carry on according to proce given in the *Shipyard Outside Machinist* manual, page 129.

V. Assignment:
(Pumps or mock-ups should be available so that each pair of trainees may from a blueprint and locate, level, and measure for chocks as a typical p job requires.) Have selected trainees work from a blueprint and locate a p unit, and level and measure for chocks.

VI. Time — 3 to 6 hours.

TOPIC NO. 37

TOPIC — Aligning Pumps and Motors; Aligning Couplings

TOOLS AND EQUIPMENT

1. Center punch
2. Scale
3. Hammer
4. Dividers
5. Chalk line
6. Drilling machine
7. Drills
8. Reamer
9. Files
10. Chock sheets
11. Air grinder
12. Straightedge
13. Inside calipers
14. Outside calipers
15. C-clamps
16. Dial indicator
17. Thickness gauge
18. 6′ scale
19. Three-piece, flanged coupling shaft
20. Two-piece, flexible coupling shaft

SUPPLIES

Chalk
Chocks
Bolts
Mock-up foundation
Marking paint
Flexible couplings
Steel blocks
Wedges
Side jacks
Set screws
Shims

REFERENCE — *Shipyard Outside Machinist,* pages 130 and 132.

INSTRUCTIONAL AIDS

A. Wall chart showing pump and motor installed.

B. Blueprints of pump and motor units.

TEACHING HINTS:

A. Safety:

1. Be careful to avoid injuries caused by contact with miscellaneous material and equipment on the classroom floor or on the ship's deck.
2. Watch for the movement of other workmen to avoid causing accidents.

B. Information to be presented:

1. Location of pump and motor units.
2. Purpose of gear-reduction sets.
3. The work the pipefitter does in connection with aligning pumps and motors.

4. How added weight on the deck affects the alignment of previously inst le pumps and motor units.
5. How changes in temperature affect the alignment of shafting.
6. Reasons for checking alignment at the same time each day.
7. Why the motor should be aligned with the pump instead of aligning th pump with the motor.

C. Demonstration by the instructor:
1. How to place wedges and blocks under the unit.
(Have available a pump and motor unit to be aligned on the foundat n.
2. How misalignment can be detected and corrected by the use of a 6″ s a thickness gauge, or an indicator.
(Stress the fact that the motor is aligned with the pump and not th pump aligned with the motor. The pump is not to be moved.)
3. How the sides of the coupling flanges may be aligned and checke b using the 6″ scale.
4. How the alignment may be done with a thickness gauge or with an indicator.

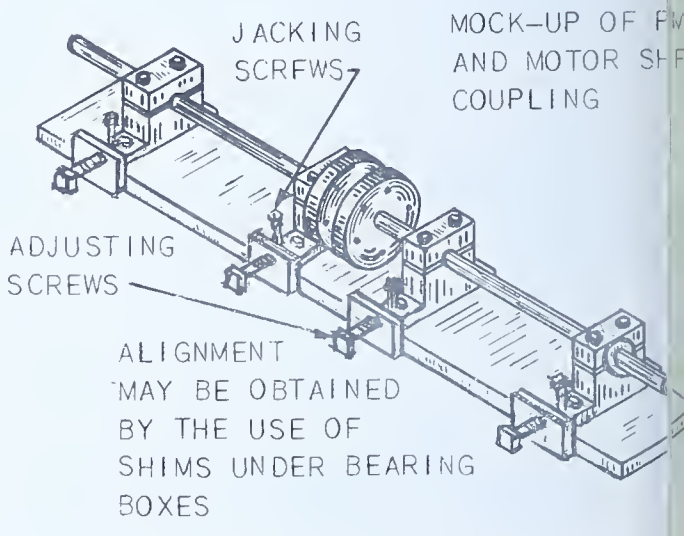


Fig. 10 — *Mock-up Coupling Aligning Job.*

D. Student practice:
1. Assign shaft and coupling mock-up, as shown in Fig. 10, to pairs of trainees.
2. Have trainees align coupling faces and outside diameters of the flanges and check the alignment successively i scale, thickness gauge, and indicator.
3. Check the work of each trainee and have the trainees inspect the o done by other trainees.

V. Assignment:
(Have available the pump and motor units.)
1. Assign a job of placing, leveling, and aligning units.
2. Have trainees answer questions on page 136 of the *Shipyard Outside Ma i ist* manual.

VI. Time — 24 to 27 hours.

TOPIC NO. 38

Topic — Overhauling a Pump.

Tools and Equipment	Supplies
1. Hammer	Used pump
2. End wrenches	Cast-iron piston rings
3. Dividers	Steam sheet packing
4. Center punch	Spare piston rod
5. Packing hook	Details as shown in Fig. 183, *Shipyard Outside Machinist,* page 142.

Reference — *Shipyard Outside Machinist,* page 136.

Instructional Aids

A. Wall charts of various types and sizes of pumps.

B. Steam pump on classroom floor.

Teaching Hints:

A. Safety:

1. Be careful to avoid pinching the fingers. Abrasions often become dangerously infected.
2. Watch the movements of other workmen to avoid causing injuries.
3. Work carefully to avoid tripping over miscellaneous objects on the floor.

B. Information to be presented:

1. Review the topic "Overhauling a Pump", page 136, *Shipyard Outside Machinist.*
2. How to identify the various pumps and pump parts. Refer to charts and actual pump examples.
3. The purpose of each type of pump.
4. A review of the locations of various types of pumps throughout the ship.

C. Demonstration by the instructor:

1. How to open a horizontal duplex pump for renewing piston rings, liquid-end piston, and packing.

2. How to remove the piston-rod assembly.
(Have ready a new piston rod and items shown in Fig. 183, *Shipyd Outside Machinist* manual, pages 1 and 2.)

3. How to determine what parts need replacement by comparison of the d assembly with the new one.

4. How to install new piston rings.

5. How to install new liquid-piston packing.

6. How to reassemble the pump.

D. Student practice:
(Divide the class into as many groups as there are available pumps t which to work.)

1. Have groups of trainees tear down the pumps for the purpose of installi new piston rings.

2. Have the trainees install new piston rings.

V. Assignment:

1. Have prepared check sheets, and test the trainees regarding their use of to s and their ability to use correct terminology.

2. Have the trainees answer questions on page 146 of the *Shipyard Outs e Machinist* manual.

VI. Time — 12 to 15 hours.

TOPIC NO. 39

TOPIC — Spotting and Scraping Bearings

TOOLS AND EQUIPMENT

1. Spoon scraper
2. Flat scraper
3. 6″ thickness gauge
4. 12-point box wrench to fit lower end nuts
5. Center punch
6. Machinist's hammer
7. Tin snips
8. 3′ pinch bar
9. 1″ micrometer
10. 20-lb. maul (sledge)
11. 2 1-ton chain hoists
12. 1 3-ton chain hoist
13. Electric drop-extension cord (30′ or longer)
14. End scraper
15. Mock-up of diesel piston and rod assembly.

MATERIALS

Prussian blue
Lead wire, .018″ in diameter
Shim stock, .002″, .005″, .010″
Cleaning fluid
Cleaning rags
Cup grease
Lead cards
Mock-up bearing } Fig. 11
Mock-up journal }

REFERENCE — *Shipyard Outside Machinist*, page 147.

INSTRUCTIONAL AIDS

A. Wall chart of Diesel-engine cross section.

B. Blueprints of Diesel-engine crankshaft, main rod, side rod.

TEACHING HINTS:

A. Safety:

1. Be careful to avoid undue personal strain when lifting and handling heavy castings and forgings. Obtain sufficient help when the job is too much for one man.

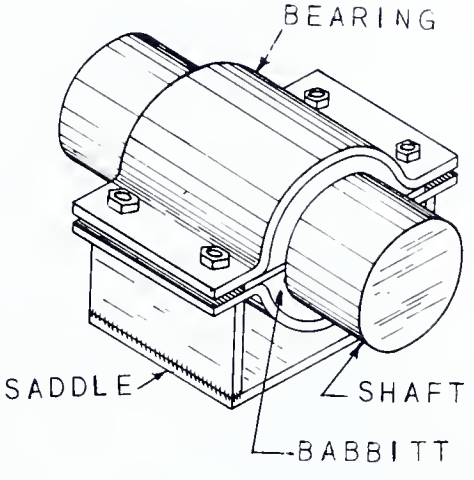


FIG. 11 — *Mock-up Bearing and Journal*

2. Make sure that all chain hoists and other rigging-tackle fastenings are secure. Much damage may be caused if fastenings "let go".

B. Information to be presented:

1. The meaning of the term "scraping" a bearing.
2. The nature of bearing surface material.
3. The responsibility of the workman when scraping and fitting diesel-engine bearings.
4. The several steps followed in spotting and scraping bearings, beginning on page 148 of the *Shipyard Outside Machinist* manual.
5. The care and use of the tools which are employed in spotting and scraping bearings.

C. Demonstration by the instructor:
(Have ready a mock-up upper-half bearing and journal to be fitted.)

1. How to spot the bearing and "scrape it in".
2. How to relieve the horns of the upper half and secure the crankshaft preparatory to fitting the bottom half.
3. How to pull the bottom half up and proceed to spot and scrape it in.
4. How, when the bearing is scraped in, to proceed to pull the bolts up tightly.
5. How to use a lead card and leads, and how to check the bearing fit for accuracy.
6. How to adjust shims.

D. Student practice:

1. Have trainees use mock-up bearings and journal and practice spotting and scraping bearings.
2. Have trainees check the work of others.
3. (Have ready a mock-up main rod and journal). Have the trainees use a light chain hoist to pull the rod up into scraping position. Repeat this several times until every trainee has had an opportunity to perform the operation.

V. Assignment:

1. Have the trainees place the crankshaft at top and bottom dead center respectively.
2. With the main rod and crankshaft in position at top dead center, have the trainees pull the bottom half of the bearing up and install the nuts.
3. Have the trainees take leads and check the bearing fit.
4. Have the trainees adjust shims to obtain a good bearing fit.

VI. Time — 12 to 15 hours.

TOPIC NO. 40

Topic — Installing Operating Rods.

Tools and Equipment

1. Portable air drill
2. Open-end or adjustable wrench. ¼ to 1″ U. S. S.
3. Taper reamer for No. 6 taper pin
4. Drill for No. 6 taper pin (See Chart)
5. Six-foot steel tape
6. Fifty-foot steel tape
7. Chalk line
8. Center punch
9. Machinist's hammer
10. 10-inch dividers
11. Punches and wedges
12. Pliers
13. Level
14. Declivity board
15. Calipers
16. 6″ scale
17. Hack saw
18. Stillson wrench
19. Plumb bob
20. Support and clamp to hold operating rod while fitting "steps" on rod ends.

Supplies

Soapstone pencil
Blue or white chalk
Mock-up bulkheads, tank bottom, and weather deck. (Deck stand to be installed on weather deck and a valve to be installed on tank bottom)
Operating rods, bracket stock, and fittings.

Reference — *Shipyard Outside Machinist,* page 153.

Instructional Aids

A. Wall chart showing operating rod details. (Deck stand, support brackets, couplings, valve, etc.)
B. Actual deck stand mounted on mock-up deck.
C. Actual valve mounted on mock-up deck.
D. Blueprints of operating-rod installations.

Teaching Hints:

A. Safety:
   1. Be careful when handling tools and materials. Avoid dropping objects and injuring other workmen.
   2. Make sure while working in a tank, or while going up and down from level to level, that scaffolding, ladders, and supports are secure. Take no chances of falling.

B. Information to be presented:

1. The correct procedure for installing operating rods, beginning on page 153 of the *Shipyard Outside Machinist* manual.
2. The reasons why operating rods must be installed to turn freely.
3. Why bearing brackets are installed close to couplings and joints. ("Whip" must be eliminated.)

C. Demonstration by the instructor:

1. How steps are fitted together and held with couplings.
2. How pin holes are drilled, reamed, and fitted with taper pins.
3. How measurements are taken for lengths of operating rods.
4. How the locations of support brackets are found.
5. How split bearings are installed in angle clips and how the assembly is secured with bolts.
6. How pointers are adjusted on the deck stands.
7. How the operating-rod fork is adjusted to work freely in the yoke or valve wheel.

D. Student practice:

1. Divide the group into pairs and have each pair cut and fit steps on operating rods.
2. Have the trainees fit couplings to the rod ends.
3. Have the trainees drill, ream, and fit taper pins through couplings and operating rods.
4. Have trainees measure for lengths of operating rods and prepare to install a complete operating rod.

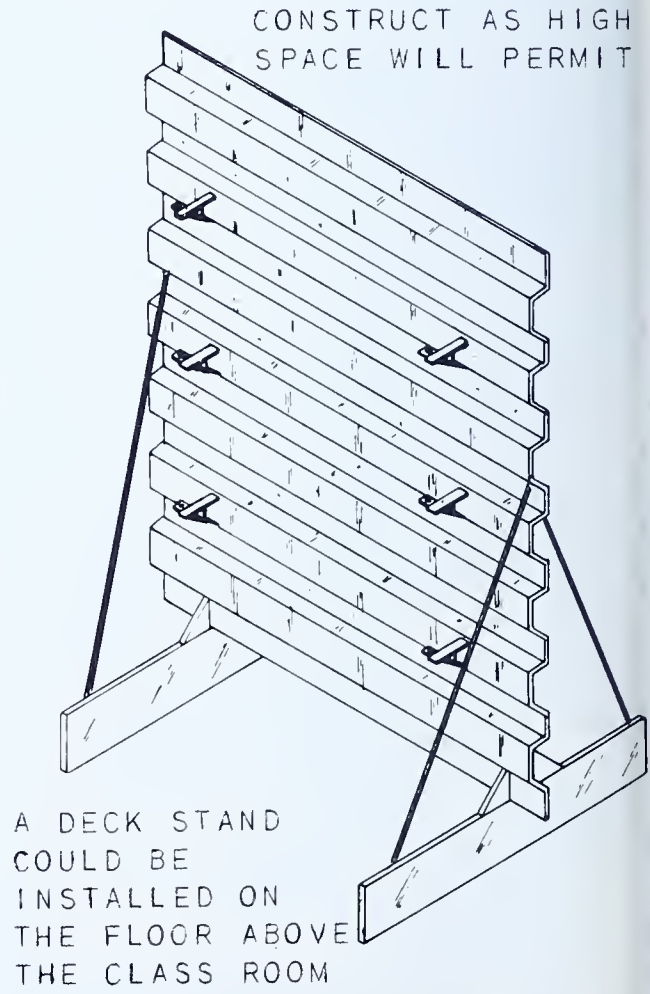


FIG. 12 — *Mock-up Bulkhead*

5. Follow the procedure beginning on page 156 of the *Shipyard Outside Machinist* manual, and have the trainees install an operating rod, complete. (The trainees may alternate in doing the work. Check the job carefully, and discuss the procedure, step by step.)

ASSIGNMENT:

1. Have the trainees answer questions on page 157 of the *Shipyard Outside Machinist* manual.

2. (Have a blueprint of an operating rod to be installed; have the necessary material and fittings at hand.) Have the trainees install an operating rod on the previously set up mock-up bulkhead. See Fig. 12. (Each trainee should work on his own material, and he should be scored on the final job.)

TIME — 6 to 9 hours.

TOPIC NO. 41

I. Topic — Fitting a Sea Chest Strainer Plate.

II. Tools and Equipment

1. Scale
2. Machinist's hammer
3. Center punch
4. Set of open-end wrenches
5. Flat cold chisel
6. Scriber
7. Drills for the job
8. Taps for the job
9. Air grinder
10. Stud driver

Supplies

Mock-up section with opening prepared to receive a strainer plate. See Fig. 13
Several strainer plates, studs, brass nuts brass split pins.

III. Reference — *Shipyard Outside Machinist,* page 158.

Instructional Aids

A. Wall chart showing various strainer-plate installations.

B. Mock-up of installed strainer plate.

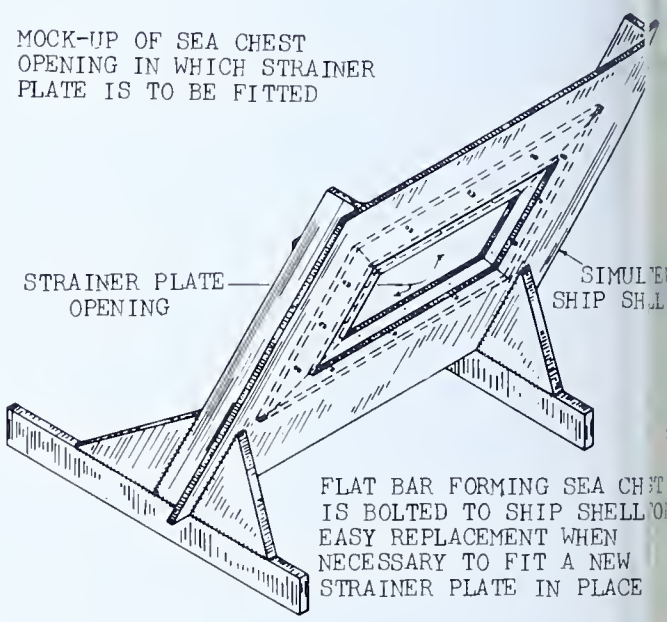

MOCK-UP OF SEA CHEST OPENING IN WHICH STRAINER PLATE IS TO BE FITTED
STRAINER PLATE OPENING
SIMUL'E SHIP SH.L
FLAT BAR FORMING SEA CH'T IS BOLTED TO SHIP SHELL 'O EASY REPLACEMENT WHEN NECESSARY TO FIT A NEW STRAINER PLATE IN PLACE

Fig. 13 — *Mock-up Sea-Chest Opening*

IV. Teaching Hints:

A. Safety:

1. Be careful to have scaffolding secure and at a correct height to avoid slipping or overreaching.
2. Avoid cuts and abrasions which often cause dangerous infections.

B. Information to be presented:

1. The correct procedure for "Installing a Sea Chest Strainer Plate", beginning on page 158 of the *Shipyard Outside Machinist.*
2. The difficulties which are encountered when installing a strainer plate in various locations.
3. The procedure followed where it is necessary to replace broken studs.

C. Demonstration by the instructor:

1. How a strainer plate should be fitted.
2. How a strainer-plate stud location may be marked.
3. How to begin fitting and locating the strainer plate so as finally to secure a tight job.
4. How to drive and tap a stud hole.
5. How to drive a stud and tighten it in a threaded hole.
6. How to draw a strainer plate down on the first studs.

D. Student practice:

1. Have the trainee locate a strainer plate and fasten it with the first two studs.
2. Have the trainee scribe, center, and drill the holes for the next two studs.
3. Have a second trainee drive the studs home and replace the strainer plate.
4. Have a third trainee draw the nuts down tight.
5. Have a fourth trainee scribe, center, and drill the holes for the next two studs.
6. Proceed in this manner until the strainer plate is installed.
7. Repeat the procedure of installing a strainer plate until every trainee is proficient.

ASSIGNMENT:

1. Have the trainees answer the questions on page 160 of the *Shipyard Outside Machinist* manual.
   (Have ready a mock-up of ship shell and a strainer plate to be installed. Several of these mock-ups are desirable.)
2. Assign a job of installing a strainer plate to each pair of trainees and have them work alternately.
   (Check the work as it progresses and make sure each trainee does a good job.)

TIME — 6 to 9 hours.

TOPIC NO. 42

I Topic — Installing a Valve.

II Tools and Equipment

1. ½-ton chain hoist
2. Machinist's tool kit

Supplies

12" main suction valve
12 1⅛" x 4½" stud bolts
12 1⅛" boiler washers
⅛" x 18" hexagon nuts
⅛" x 18" wire-inserted sheet rubber (1 piece)
Ship-shell mock-up with dummy sea-chest flange welded in place. See Fig. 14.

III. Reference — *Shipyard Outside Machinist,* page 161.

Instructional Aids

A. Wall chart showing valve installed.
B. Blueprint of main suction-valve installation.

IV. Teaching Hints:

A. Safety:

1. Be careful to have scaffolding secure and at the correct height to avoid slipping or overreaching.
2. Avoid cuts and abrasions which often cause dangerous infections.

B. Information to be presented:

1. The correct procedure for "Installing Main Suction Valve", beginning on page 161 of the manual.
2. The difficulties encountered when installing valves; the necessity for working in inconvenient places and und adverse conditions.
3. How the correct position and location of the main suction valve is iden fied on the blueprint.
4. How the valve is brought into the ship and placed where the work is be done.

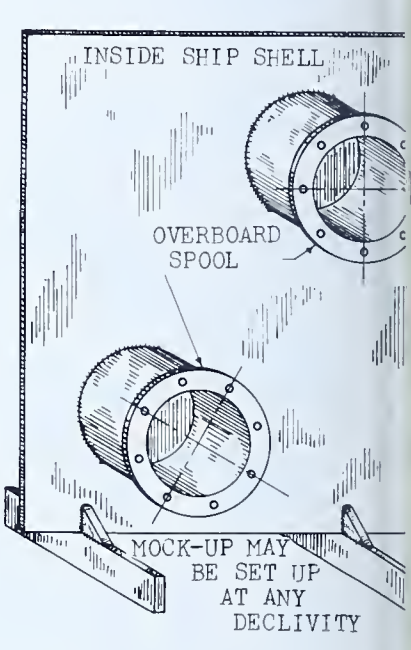


Fig. 14 — *Dummy Flanges*

C. Demonstration by the instructor:

1. How to select and place the first stud on the sea-chest flange.
2. How to fasten the valve to the chain hoist safely preparatory to raisi it into position.

For this purpose a sling should be hung from the ceiling of the classroo or ship in which the demonstration is being given. A chain hoist is th

hooked in the sling, and the valve is dragged to a position comparable to the conditions which will exist in actual practice. The valve is then raised or swung into position.

3. How to identify the hole in the valve flange which is to be placed over the stud previously inserted in the sea-chest flange. See Fig. 213, page 162 of the *Shipyard Outside Machinist.*
4. How to raise the valve into position on the first stud. Have one or two trainees help.
5. How to check the hole locations in the valve flange to see if the studs can be inserted correctly.
6. How to insert the studs in as many places as the alignment of the holes will permit.
7. How to ream or file the flange to match the stud hole in the spool or sea-chest flange.
8. How to put the washers on the studs, place the nuts, and pull them down hand-tight.

D. Student practice:

1. Have the trainees remove the nuts and washers from the mock-up valve flange, remove the studs, and lower the valve to the floor.
2. Select three trainees and have them assemble the valve on the sea-chest flange in accordance with the demonstration previously given.
3. Repeat with other trainees until each trainee in the group has had an opportunity to practice the operation.

ASSIGNMENT:

1. Have trainees answer questions on page 163 of the manual.
2. Call for volunteers from the group to explain procedure that has just been demonstrated and practiced.
3. Select three trainees to outline the procedure correctly and have them install a suction valve correctly on the mock-up sea-chest flange.

TIME — 6 to 9 hours.

TOPIC NO. 43

I. Topic — Installing Overboard Spools.

II. Tools and Equipment

1. Combination square with protractor
2. A chalk line
3. Declivity board
4. Trammels
5. Hammer
6. Center punch
7. 6′ tape
8. Mock-up of a ship shell with an opening provided around which the overboard spool is welded. See Fig. 15.

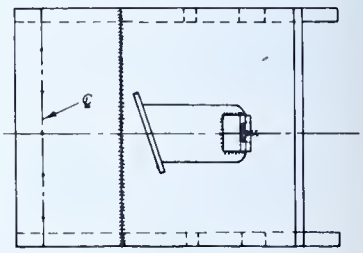
Materials

Chalk
Blueprint
Overboard spool suitable for this tra
ing project

III. Reference — *Shipyard Outside Machinist*, page 163.

Instructional Aids

A. Wall chart showing an overboard spool installed.
B. Blueprint showing overboard spool installation.



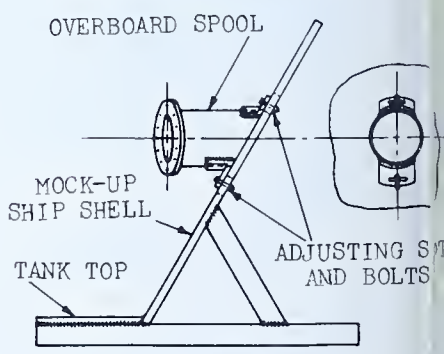


Fig. 15 — *Mock-up Ship Shell*

IV. Teaching Hints:

A. Safety:
   1. Be careful to have scaffolding secure and at a correct height to avoid slipping or overreaching.
   2. Avoid cuts and abrasions which often cause dangerous infections.

B. Information to be presented:
   1. The correct procedure for "Installing Overboard Spools", beginning on page 163 of the manual.
   2. Difficulties which will be encountered when installing overboard spools at various locations.

C. Demonstration by instructor:
   1. How to locate the opening which received the spigot end of the overbo spool.
   2. How to scribe, with the trammels, the circumference of the spigot diame
   3. How to center-punch-mark the circumference of a circle.

   The last two steps should be carried out on a separate sheet of boiler pla
   The opening for the spigot and for the overboard spool is burned

ready to receive the spigot end. Locating the position of the openings may be done by "bridging" the opening at each demonstration.

4. How to align the face of the flange at a 22° angle with the flange end. Have the trainees help to lift the spool into place. At the same time check with the center line which will serve as a base line from which to set the overboard discharge valve. (Repeat this operation if necessary.)

   If tack welding the overboard spool in position is not practicable, there may previously be welded to the spigot end of the overboard spool two lugs, through which bolts may be passed to secure the overboard spool to the ship shell. The bolt holes may be elongated to facilitate "positioning" the installation at each demonstration.

5. How to bolt the overboard spool fast.

D. Student practice:

1. Have the trainees remove the nuts and bolts which hold the overboard spool to the ship-shell mock-up; then have them lower the spool to the floor.

2. Select three trainees and have them install an overboard spool on the ship shell in accordance with the demonstration previously given.

3. Repeat with other trainees until each trainee in the group has had an opportunity to practice the operation

ASSIGNMENT:

1. Have trainees answer questions on page 167 of the *Shipyard Outside Machinist* manual.

2. Call for volunteers from the group to explain procedure that has just been demonstrated and practiced.

3. Select three trainees to outline the procedure correctly and assign them to install the overboard spool on the ship-shell mock-up.

4. Provide an opportunity for other groups of trainees to carry out this assignment.

TIME — 6 to 9 hours.

PART III

OUTSIDE MACHINIST TRAINING
INSTALLATIONS, MAINTENANCE, AND REPAIRS

Part III

TRAINING FOR INSTALLATION, MAINTENANCE, AND REPAIRS

eaders and assistant foremen are selected from the ranks of first-class outside inists. Mechanics who are rated as first-class must be proficient in making major llations, in the maintenance of major units after installation, and in repairing pment of all descriptions when necessary.

ew employees who have had previous experience as first-class outside machinists be given immediate instruction in the work outlined in Part III. The instructors onsible for the training of those who may be candidates for the leader and tant-foreman ratings may determine what level of knowledge and skill has been ned by the individual and present such selected instruction from Part III as is idered necessary.

GENERAL COMMENTS CONCERNING INSTRUCTION FOR INSTALLATION, MAINTENANCE, AND REPAIRS

Prerequisites

general the statement of "objectives" indicates the ratings or classifications of ons who probably will be given training in installation, maintenance, and repair . The specifications for these work classifications may vary considerably de- ling on locality. Therefore, specific admission requirements should be deter- ed in conference with responsible persons in the locality for which training is g given.

OBJECTIVES OF INSTALLATION, MAINTENANCE, AND REPAIR TRAINING FOR OUTSIDE MACHINISTS

To up-grade further the outside machinist who has successfully learned the majority of the knowledge and skills outlined in Parts I and II, *Shipyard Outside Machinist.*

To train second-class outside machinists for specific installation jobs which involve the placing, aligning, and securing of heavy, intricate machinery and equipment aboard ship as well as the maintenance of these units.

To train second-class outside machinists to make permanent repairs in a skillful manner in the shortest time possible on the above-mentioned equipment

and to assume responsibility for the layout work involved in running a line, boring a stern tube, aligning a propulsion motor, etc.

NOTE: The sequence of typical jobs outlined in Part III of *Shipyard Ou Machinist* is well adapted to the training of mechanics in the skills nece for the successful performance of the work on this higher level. Advance from second-class outside machinist to first-class outside machinist req considerable yard experience in addition to the instruction given in Par

Each of these objectives must be considered separately. Classes sh be organized for each group. Training for certain work should be giv a selected group through specific block-training procedures. Select the ees on the basis of their past performance or experience. Make these tions after carefully considering the locality of the shipyard, the req ments of that particular yard, and the efficiency of the personnel al employed in that locality.

SUGGESTED MINIMUM LIST OF TOOLS, EQUIPMENT, AND SUPPLIES FOR INSTALLATIONS, MAINTENANCE, AND REPAIRS TRAINING COURSE IN SHIPYARD OUTSIDE MACHINIST

(Class of 10 to 15 Trainees)

Tools listed are in addition to the Tools required for Parts I and II

TOOLS

1. 12″ level
2. 30-lb. sledge
3. 24″ inside calipers
4. Special telescopic gauge
5. Taper gauge
6. 10-lb. maul
7. 20-lb. maul
8. Diesel side jacks
9. 1 — 12″ drill extension
10. Shipfitter's taper reamer
11. Spoon bearing scraper
12. Special trammels

EQUIPMENT

1. Tight line
2. Target stands
3. Special target-stand accessories
4. Sag blocks
5. Mock-up bulkhead
6. Small-sized portable boring bar
7. Mock-up assembly of stern-frame eye
8. Mock-up shaft alley
9. Hydraulic pump
10. Hydraulic ram
11. Strongback assemblies
12. Pull bolt, saddles, and washers
13. Stern-tube nut wrench
14. Mock-up boiler foundation
15. Melting ladle
16. Pouring ladle
17. Heating torch
18. Mock-up stern tube
19. Metal band for tight metal
20. Mock-up stator and rotor
21. Bailey Feed Water Regulator
22. No. 4 corner drilling machine
23. Oilstone
24. Two round steel bars 18″ long to fit holes in mock-up winch foundation
25. Anchor-winch mock-up
26. Wood foundation mock-up for anchor winch
27. Mock-up foundation channels
28. Wedges, blocking
29. Acetylene-welding equipment
30. Main steering-gear ram mock-up
31. Main steering-gear ram foundation mock-up
32. Chocks
33. Special spanner wrench
34. Mock-up propeller
35. Mock-up tail shaft
36. Mock-up stern frame and shaft alley
37. Mock-up fairwater
38. Mock-up scaffold
39. Model of a ship hull on the ways ready for launching

SUPPLIES

1. Cleaning rags
2. Planking and bagging
3. White lead and oil
4. Tight metal
5. Clay for mud seal
6. White-pine stick for testing temperature of tight metal
7. Insulated studs
8. Shim stock
9. Various valves, fittings, and accessories to be installed on boiler front
10. Red lead
11. Tarred felt
12. Tacks for tarred felt
13. Layout fluid
14. Chock sheets

SUGGESTED OUTLINE OF MINIMUM INSTRUCTION FOR OUTSIDE MACHINIST INSTALLATION, MAINTENANCE, AND REPAIRS

Time required: Approximately 106 to 140 hours of instruction, including talks, demonstrations, and shop practice (practical work by trainee).

1. How to run a tight line.
2. How to remove a tight line.
3. How to set a portable boring bar.
4. How to bore a stern frame.
5. How to "pull in" a stern tube.
6. How to install a propulsion motor.
7. How to install a fan and motor for an air cooler.
8. How to install accessories on a steam boiler.
9. How to install winches.
10. How to install a steering gear and telemotor.
11. How to install a propeller and tail shaft.
12. How to prepare a tanker for launching.

TOPIC NO. 44

. Topic — Running a Tight Line.

. Tools and Equipment

1. 70′ tight line
2. 6″ inside calipers
3. 12″ level
4. Hammer
5. Center punch
6. Open-end wrenches
7. Flat cold chisel
8. Adjustable wrench
9. 12″ combination square
10. 6″ scale
11. Target stands
12. Special target-stand saddles
13. Special target-stand accessories (See Figs. 17, 18, 19, 20, 21, 22, and 23)
14. Sag blocks

Supplies

Mock-up bulkhead with a 12″ hole burned through. See Fig. 16.

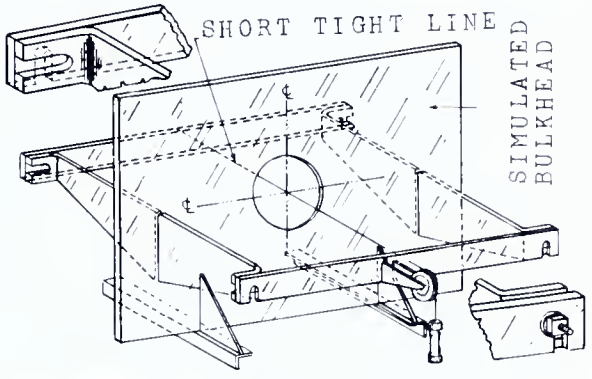


Fig. 16 — *Mock-up Bulkhead*

17 — *Special Target Stands Set Up on Classroom Floor*

III. Reference — *Shipyard Outside Machinist*, page 171.

Instructional Aids

A. Wall chart showing cross section of a ship's shaft alley with line shaft and units installed.

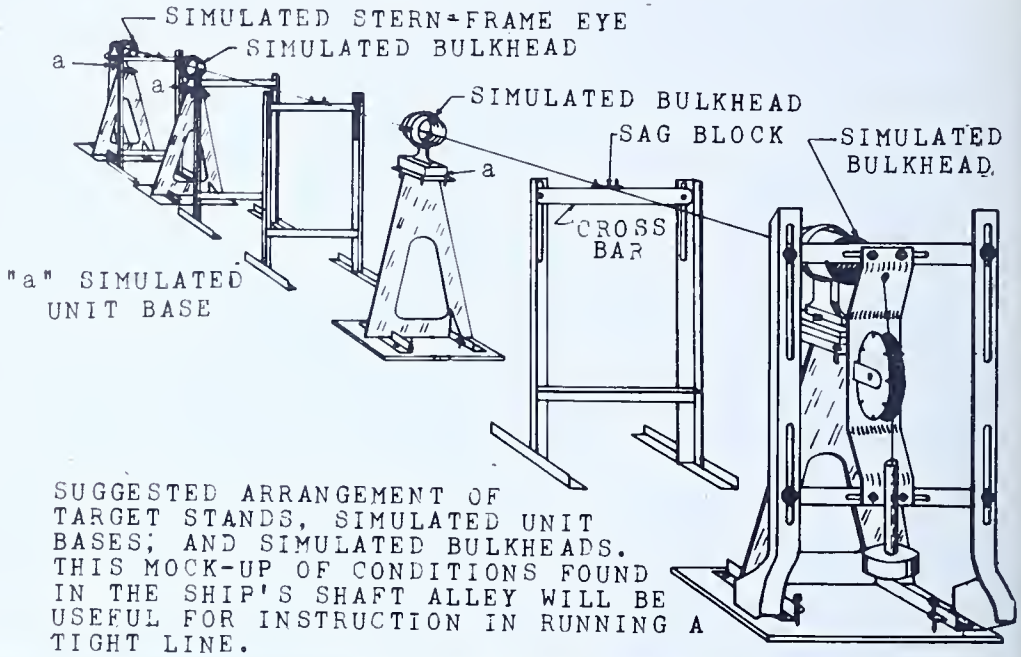
B. Blueprint of shaft-alley installations.

IV. Teaching Hints:

A. Safety:

1. Be careful to avoid overhead and at-the-side obstructions while working in a shaft alley.

2. Watch the movements of other workmen to avoid personal injuries wh may be caused by sudden contacts.



SUGGESTED ARRANGEMENT OF TARGET STANDS, SIMULATED UNIT BASES; AND SIMULATED BULKHEADS. THIS MOCK-UP OF CONDITIONS FOUND IN THE SHIP'S SHAFT ALLEY WILL BE USEFUL FOR INSTRUCTION IN RUNNING A TIGHT LINE.

FIG. 18 — *Target Stands Aligned*

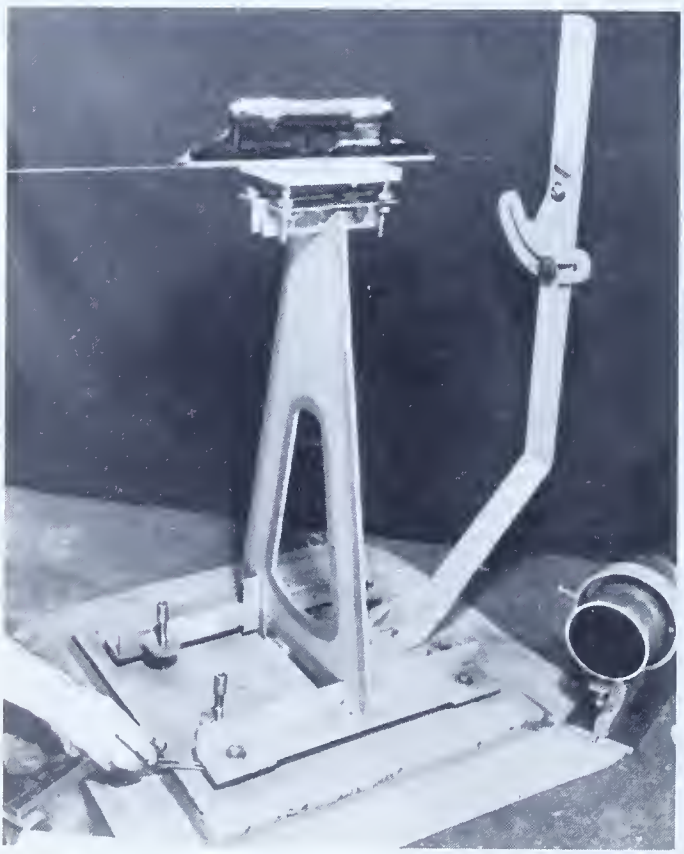


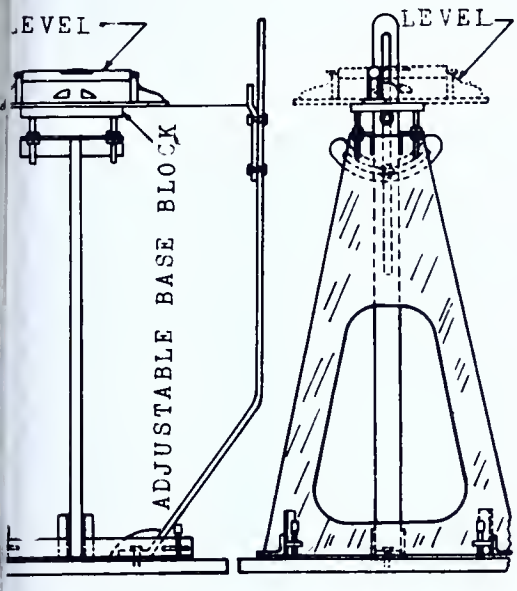
FIG. 19 — *Lining an End Target Stand in Classroom. (A level is never used aboard ship.)*

B. Information to be pe sented:

1. Review the To "Running a Ti Line" (Page 171 the manual).
2. The use of the g blocks.
3. The necessity measuring from c center of the ti line and not fr the outside diame
4. How the allowa is calculated w measuring from c center of a ti line. Explain, making calculati on the blackbo

C. Demonstration by instructor:

1. How to place ta



20 — *Details of Classroom, End Target Stand*

stands in preparation for running a tight line. See Figs. 17 and 18. (Trainees will assist.)

2. How to run a tight line and place sag blocks.
   (Have ready the mock-up bulkhead, Fig. 16, and pass a tight line through the opening, securing it on the prepared supports.)
3. How to locate machining points for the diameter to which the bulkhead is to be bored.

D. Student practice:

1. Have the trainees set target stand, according to the *Shipyard Outside Machinist* manual, instructions, page 173, "Setting the Target Stands or Supports". See Fig. 17.
2. Have the trainees run a tight line according to the *Shipyard Outside Machinist* manual instructions, pages 174, 175, and 176.
3. Have trainees review and check for accuracy the work that other trainees have done.

ASSIGNMENT:

1. Have the trainees answer the questions beginning on page 177 of the *Shipyard Outside Machinist* manual.
2. Divide the class into

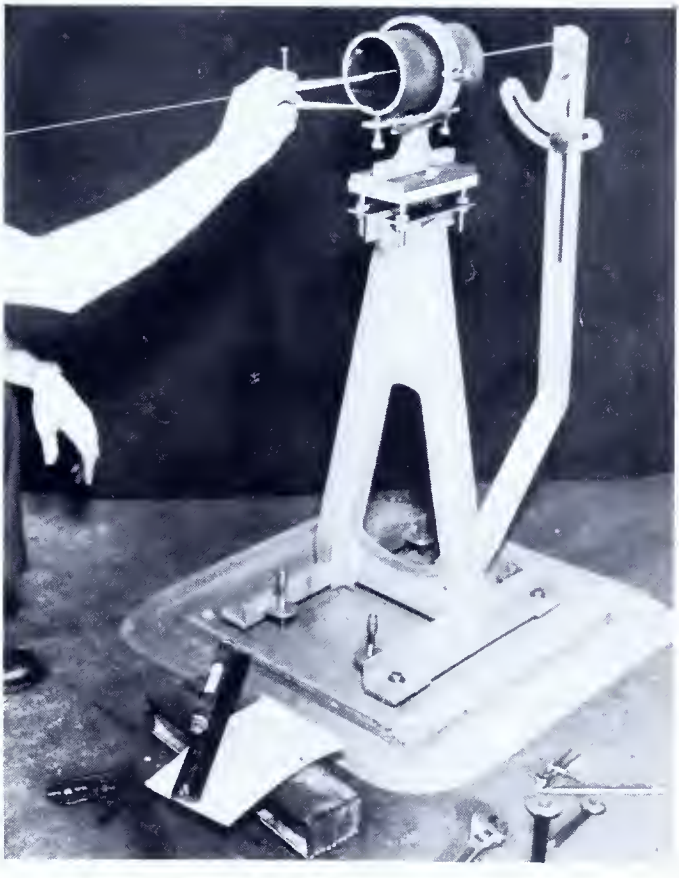


FIG. 21 — *Checking the Dummy Tube to be Certain of the Alignment with the Tight Line.*

pairs, and have each pair of trainees locate on the mock-up bulkhead, machining points for the diameter to which the bulkhead is to be bored.

3. Have two of the more capable trainees check the work for accuracy.

V. TIME — 9 to 12 hours.

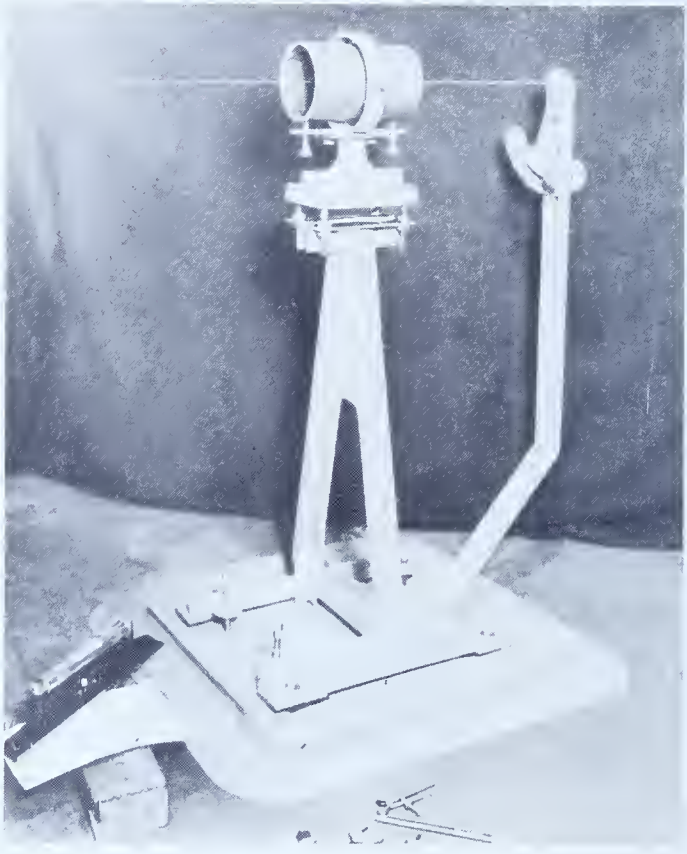


FIG. 22 — *End Target Stand with Dummy Tube Aligned.*

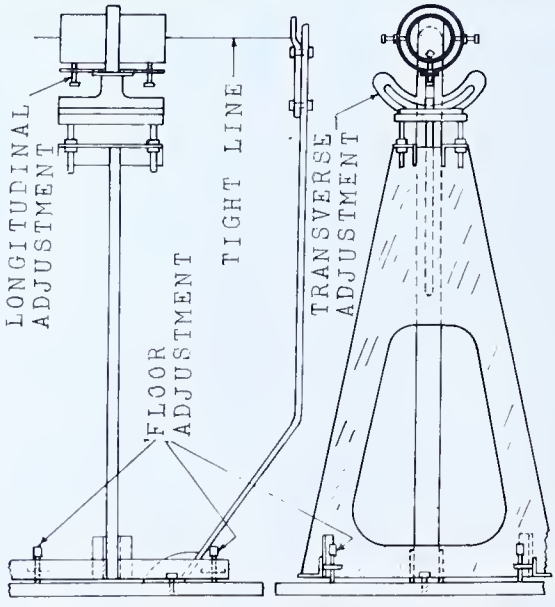


FIG. 23 — *Details of Dummy-tube Alignment.*

TOPIC NO. 45

TOPIC — Removing a Tight Line.

TOOLS AND EQUIPMENT

No tools are required to remove a tight line. It is only necessary to remove the tension weight from the end of the line near the engine-room bulkhead, apply with an oily rag a film of oil to the tight line and keep the line from kinking as it is wound up.

REFERENCE — *Shipyard Outside Machinist*, page 178.

INSTRUCTIONAL AID

A badly kinked tight line (if available)

TEACHING HINTS:

A. Safety:

1. Be careful to avoid allowing the tight line to "draw" through the hands and thus cut the flesh.
2. Never catch the tight line in a "loop" around the hand. Injury to the hand, and to the tight line, can result.

B. Information to be presented:

1. The correct method to use when removing a tight line.
2. The proper care of the sag blocks.

C. Demonstration by the instructor:

1. How to remove a tight line. (Have a trainee assist.)

D. Student practice:

1. Have two trainees remove a tight line.
2. Repeat until every trainee has had an opportunity to practice the operation.

ASSIGNMENT:

Have the trainees answer questions regarding removing a tight line. (Suitable check sheet should be available for this purpose.)

TIME — 1 to 2 hours.

TOPIC NO. 46

I. Topic — Setting a Portable Boring Bar.

II. Tools and Equipment

1. Outside machinist's tool kit
2. Small-sized portable boring bar

Supplies

A mock-up assembly of stern-frame ey
A shaft alley with three bulkheads. Se
Fig. 24
Flat bar and struts
Supply of assorted bolts and nuts
Chain hoists
Means of attaching the chain falls overhe
high enough to hold the boring bar i
position.

III. Reference — *Shipyard Outside Machinist*, page 179.

Instructional Aid

Wall chart of boring bar in place.

IV. Teaching Hints:

A. Safety:

1. Make certain the fastenings are secure when lowering the boring b into place.
2. Avoid getting the hands caught between the boring bar and a bulkhe strongback, etc.
3. Make certain that plank skids are correctly placed to prevent foot or l injuries.
4. Be sure all tack welds are well made to prevent injuries caused by po workmanship.

B. Information to be presented:

1. The purpose of the tram marks on the stern-frame eye and on the bu heads.
2. The use of the swivel stools on the yokes.
3. How the boring bar is prepared before being "passed" into position.
4. How the flat bar is used to form struts and braces for holding the bori bar in place.
5. The necessity for strongbacks outside of the stern-frame eye.

C. Demonstration by the instructor:

1. How to rig up the chain hoist and proceed to lower the boring bar in position for boring out the stern-frame eye and the bulkhead. (Ha trainees assist.)
2. How to bolt flat bar to previously prepared pad and line up the bori bar.

3. How to place supports, stools, and yokes until the boring bar is securely anchored in place.

4. How to check the location of the boring bar in relation to the tram marks previously placed on the stern-frame eye and the bulkheads.

D. Student practice:

1. Have the trainees loosen the nuts that hold the swivel stools and allow the boring bar to drop out of position.

2. Have several trainees work together at measuring from the tram marks and realigning the boring bar.

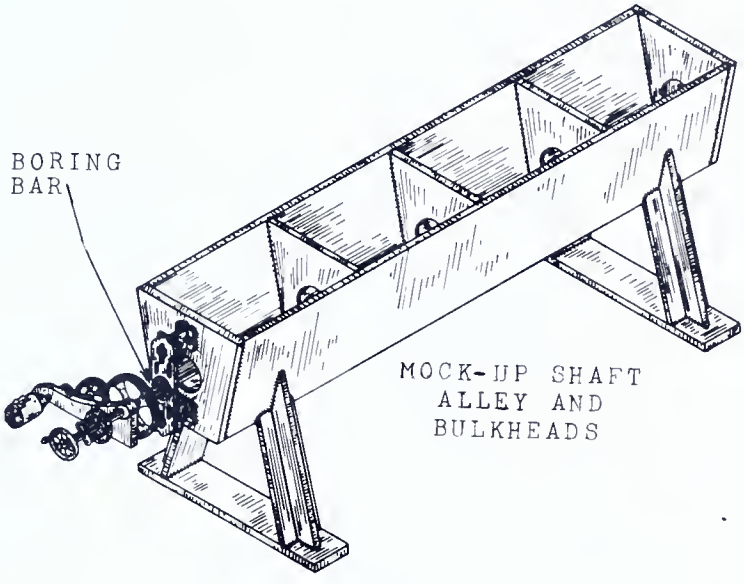


FIG. 24 — *Portable Boring Bar*

3. Have other trainees check the position of the boring bar before and after it is finally secured in place.

ASSIGNMENT:

Have the trainees answer the questions beginning on page 183 of the *Shipyard Outside Machinist* manual.

TIME — 3 to 6 hours.

TOPIC NO. 47

I. Topic — Boring a Stern Frame.

II. Tools and Equipment

1. Outside machinist's tool kit
2. Small-sized portable boring bar

Supplies

A mock-up assembly of stern-frame e See Fig. 24

A shaft alley with three bulkheads

Flat bar and struts

Assortment of bolts and nuts

Chain hoists

Means of attaching the chain hoists ov head high enough to hold the boring b in position

Planking and bagging

III. Reference — *Shipyard Outside Machinist*, page 184.

Instructional Aids

A. Wall chart of boring bar in place.

B. Blueprint of boring job.

IV. Teaching Hints:

A. Safety:

1. Keep the stage at the stern-frame eye clear of obstructions.
2. Avoid tripping or falling over air lines, electric cable lines, and water lin
3. Move carefully to avoid knocking other workmen from the staging.
4. Make certain the cutting tool is secure in the tool holder before setti the cutter head in motion.
5. Keep the hands away from the tool while the cutting head is in motion

B. Information to be presented:

1. The instructions for boring a stern frame, beginning on page 184 of te *Shipyard Outside Machinist* manual.
2. The steps which should be taken to bore the holes in the mock-up, ste frame-eye bulkhead.

C. Demonstration by the instructor:

1. How to adjust the tool holder and tool bit; turn the bar to find the high spots on the bore, locate the tool in place, and begin boring.
2. How to set the tool, find the high spots, and adjust the feed.
3. How to continue boring the stern-frame eye.
4. How to check the diameter for size.

D. Student practice:

1. Have the trainees continue the boring job. (Each trainee will bore for a short distance and then another trainee will take his place until the hole is completely bored through.)
2. Have a trainee set up for a new diameter on the first bulkhead and begin boring.
3. Have other trainees take turns at the boring bar until the bulkheads are bored.

ASSIGNMENT:

1. Divide the trainees in groups of three and have each group take a finish cut out of the holes already bored. (The instructor will give the diameter to which each hole is to be bored. The correct diameter for the stern tube should be given in thousandths.)
2. Have the trainees answer the questions on page 188 of the *Shipyard Outside Machinist* manual.

TIME — 9 to 12 hours.

TOPIC NO. 48

I. Topic — "Pulling in" a Stern Tube.

II. Tools and Equipment

1. Hydraulic pump
2. Hydraulic ram
3. Strongback assemblies
4. Pull bolt
5. Saddles for pull bolt
6. Washers for pull bolt
7. Stern-tube nut wrench
8. Drill for lock stud
9. Air drill
10. 30-lb. sledge
11. Chain hoist
12. Melting ladle
13. Pouring ladle
14. Heating torch

Supplies

Planking for skids and platform
White lead and oil
Lock stud
Mock-up stern tube
Tight metal
Clay for mud seal
Metal band for tight metal
Ladle and heating torch
White-pine stick for testing tight-metal temperature
Shaft-alley mock-up. See Fig. 25

III. Reference — *Shipyard Outside Machinist*, page 188.

Instructional Aids

A. Wall chart showing stern tube in place.

B. Blueprint of a stern-tube job.

IV. Teaching Hints:

A. Safety:

1. Avoid stepping backward.
2. Be careful not to trip over ropes, wires, or chains used in the rigging gear.
3. Keep clear when pressure is applied.
4. Watch for escaping hot metal when tight metal is poured.
5. Always wear goggles when pouring hot metal.
6. Particularly stress the care which should be used in handling tools and materials to prevent damage and resulting inaccuracies.

B. Information to presented:

"Pulling In" a Stern Tube, beginning on page 188, *Shipyard Outside Machinist* manual.

C. Demonstrations by the instructor:

1. How to lower the stern tube into position for "pulling in". (With the assistance of the trainees.)
2. How to install the pull bolt and adjust strongbacks and hydraulic ram. (With the assistance of trainees.)
3. How to begin pulling the tube into place.
4. How to check the job for accuracy. (Proceed slowly and repeat the operations until the trainees are thoroughly familiar with this checking procedure.)

D. Student practice:

1. Have the trainees continue pulling in the stern tube to place. (Have the trainees check the job frequently for accuracy.) See page 191, *Shipyard Outside Machinist* manual.
2. Have the trainees change places so that each trainee does more than just one part of the work.
3. When the stern tube is in place, have the trainees remove the strongbacks and other equipment and prepare to drill the holes in the bulkhead.

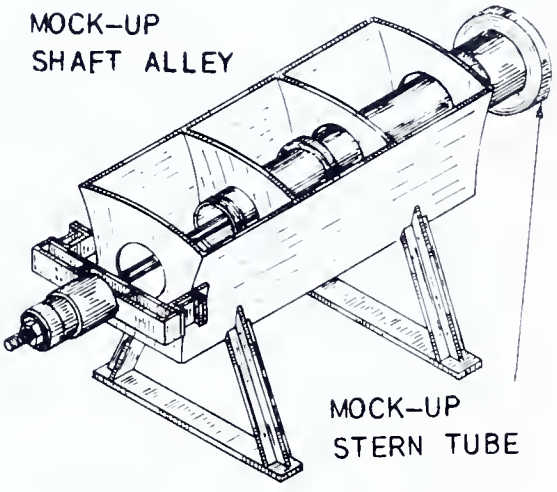


FIG. 25 — *Mock-up Shaft Alley*

4. Drill holes in bulkhead and tap for studs.
5. Install studs with grommet and nuts on the after side of the stern-tube bulkhead. The instructor will assist the trainees in placing a band around the flange of the stern tube for the purpose of pouring tight metal.
6. Have the trainees assist in building up a clay mud seal all around the metal bar.
7. Have trainees assist in heating the tight metal to the proper temperature. Have other trainees assist in pouring the tight metal. Have other trainees calk the tight-metal joint. Have trainees install washers and nuts on the studs.
8. Have trainees draw the nuts up tight. See Fig. 243 in the *Shipyard Outside Machinist* manual.
9. Answer the questions on page 193, *Shipyard Outside Machinist* manual.

TIME — 9 to 12 hours.

TOPIC NO. 49

I. Topic — Installing a Propulsion Motor.

II. Tools and Equipment

1. Drills of the correct size
2. Corner drilling machine
3. Reamers for couplings (taper and straight)
4. Reamers for hold-down bolts
5. Set of open-end wrenches
6. Scrapers
7. 6″ scale
8. Thickness gauge (.002″-.060″)
9. 24″ inside calipers or Special telescopic gauge
10. Taper gauge (0″-.390″)
11. Center punch
12. Machinist's hammer
13. 10-lb. maul
14. 20-lb. maul
15. Necessary taps
16. Jacking screws
17. Diesel side jacks

Supplies

Shim stock

Mock-up stator and rotor on a base. Fig. 26)

Insulated studs

Cross section of an insulated stud installation as shown in Fig. 246, *Shipyard Outside Machinist* manual.

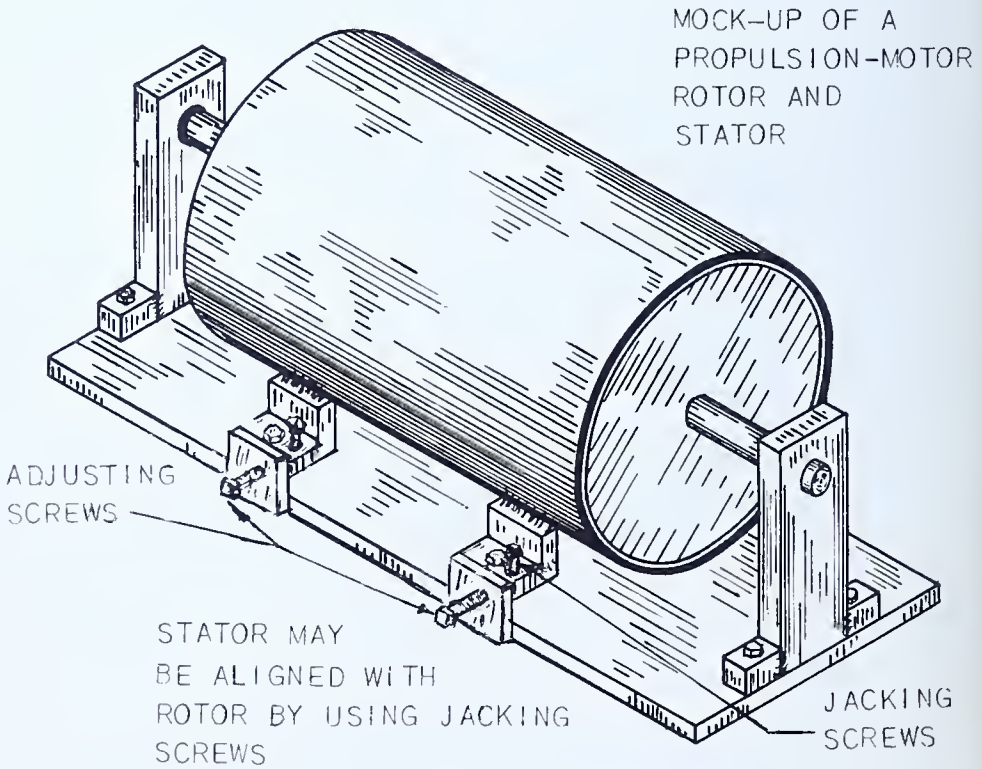

MOCK-UP OF A PROPULSION-MOTOR ROTOR AND STATOR
ADJUSTING SCREWS
STATOR MAY BE ALIGNED WITH ROTOR BY USING JACKING SCREWS
JACKING SCREWS

Fig. 26 — *Mock-up Stator and Rotor*

REFERENCE — *Shipyard Outside Machinist* manual, page 193.

INSTRUCTIONAL AIDS

A. Wall chart of a stator and rotor in alignment.

B. Blueprints of a propulsion-motor installation.

TEACHING HINTS:

A. Safety:

1. Watch carefully the movements of other workmen to avoid causing injuries.
2. Inspect carefully fastenings and any planking that may be used. Fastenings must be secure and planking must be sound in order to prevent injuries to workmen and damage to the unit being installed.

B. Information to be presented:

1. The procedure for "Installing a Propulsion Motor", page 193 in the *Shipyard Outside Machinist* manual.
2. Why the stator is set first and aligned last.
3. The necessity for having the chock-fitting job checked and re-checked for accuracy.
4. The reason for the extreme care that must be used when drilling and reaming for the corner-fitted bolts.
5. The reason for using insulated fitted bolts in the forward bearing.

C. Demonstrations by the instructor:

1. How the taper gauge is used to bring the stator into perfect alignment with the rotor.
   (Point out, as shown in Fig. 243, page 191 of *Shipyard Outside Machinist* manual, that in actual practice, jacks are used to align the stator with the rotor on the propulsion-motor base.)
2. How the stator is lined up with the rotor .005″ above the center to allow for "settling" in the bearing, which will thus bring the rotor true with the stator after "running in".

D. Student practice:

1. Divide the trainees into groups of three, and have each group line up the stator with the rotor in the mock-up motor.
   (Check the work carefully and criticize.)
2. Repeat this step until every trainee has had an opportunity to become thoroughly acquainted with what is required.

ASSIGNMENT:

1. Have the trainees answer the questions on page 198, *Shipyard Outside Machinist* manual.
2. Review the entire aligning procedure.
3. Call for volunteers to explain the sequence of steps taken in the alignment.

TIME — 9 to 12 hours.

TOPIC NO. 50

I. Topic — Installing Fan and Motor for Air Cooler.

II. Tools and Equipment

Tools and equipment required for the installation of an air-cooler fan and motor will depend to some extent on the type of unit which is being installed. When preparing to give instructions on the installation of a certain type of unit, the instructor will have ready the proper tools and equipment for the job.

Supplies

Mock-up unit of either a Westinghouse General Electric or both. The instruc will be required to exercise his ingenu in the preparation and in the use of mod when presenting this topic to the cla

III. Reference — *Shipyard Outside Machinist,* page 198.

Instructional Aids

A. Photographs of charts of air-cooler units.

B. Blueprints of air-cooler installation.

IV. Teaching Hints:

A. Safety:

1. Watch carefully the movements of other workmen to avoid causing injuri.
2. Inspect carefully fastenings and any planking that may be used. Fast ings must be secure and planking must be sound in order to prevent juries to workmen and damage to the unit being installed.

B. Information to be presented:

1. The procedure, beginning on page 198 of the *Shipyard Outside Machinist* manual for "Installing Fan and Motor for Air Cooler".
2. How the location of the unit is determined at the time of installation.
3. The necessity for having the unit properly leveled before fitting the chock.

C. Demonstration by the instructor:
(Have ready a mock-up unit and a previously prepared wooden cushion.)

1. How to level the unit on the wooden cushion ready for bolting down.
2. How to drill, ream, and install fitted bolts and draw down.
(Only one fitted bolt may be installed, leaving the others for stude practice.)

D. Student practice:

Select trainees and have them drill, ream, and install the rest of the fitted bolts in the unit base. (Different trainees may work on each corner bolt.)

ASSIGNMENT:

1. Review the installation procedure with the class.
2. Have the trainees answer oral questions.
3. Select trainees (two) and have them demonstrate the steps necessary to install fan and motor for an air-cooler unit. (Trainees will use a mock-up prepared for class instruction.)

TIME — 6 to 9 hours.

TOPIC NO. 51

I. Topic — Installing a Steam Boiler.

II. Tools and Equipment

1. 50′ steel tape
2. Trammels
3. Machinist's hammer
4. Center punch
5. Flat cold chisel
6. Drilling machine
7. ½″ twist drill
8. Drift
9. Chalk line
10. Open-end wrenches
11. Adjustable wrench

Supplies

Chalk

Mock-up of boiler foundation

Mock-up boiler front to be set on foun tion

Various valves, pipe fittings, gauges, a other accessories to be installed on boiler front

Bailey Feed Water Regulator

III. Reference — *Shipyard Outside Machinist,* page 201.

Instructional Aids

A. Wall chart showing cross section of Babcock and Wilcox oil-fired boil. Babcock and Wilcox, 85 Liberty Street, New York, N. Y.

B. Blueprint of steam-boiler installation. (local source)

IV. Teaching Hints:

A. Safety:

1. Be sure to use the correct size of wrench to avoid injury to fittings a hands.
2. Avoid tripping or falling over hose lines, electric cables, and miscella ous equipment lying on the floor or deck.

B. Information to be presented:

1. The procedure, page 201 in the *Shipyard Outside Machinist* manual, f "Installing a Steam Boiler".
2. The location of the boiler on the foundation. (How the location is foun

3. Laying off the location on the boiler foundation. (Illustrate on the blackboard.)
4. Identification and use of gauges, valves, and other accessories.
5. The correct wrench to use when installing the accessories.
6. How threads may be damaged if the proper care in handling is not observed.
7. How to distinguish between a right-hand and a left-hand thread.

C. Demonstration by the instructor:

1. How to find the centers on the mock-up foundation. (With the assistance of the trainees lay off the center lines. See Fig. 28.)
2. How to find the bolt-hole centers on the blueprint and lay them off correctly (Have the bolt holes drilled by trainees.)
3. How to place the mock-up boiler front on the foundation and bolt it down. (With the assistance of the trainees.)
4. How to install a few gauges, valves, and other accessories. (Work slowly enough for trainees to grasp and understand the procedure.)
5. How to install a Bailey Feed Water Regulator, *Shipyard Outside Machinist* manual, page 255, page 206.

D. Student practice:

1. Have the trainees study the blueprint and find the centers on the boiler foundation.
2. Have the trainees lay off the center lines on the foundation. (Check for accuracy.)
3. Have other trainees lay out the bolt holes in the foundation.
4. Have other trainees check the position of the drilled holes for accuracy.
5. Have the trainees place the boiler mock-up on the foundation and bolt down.
6. Have the trainees install various valves, gauges, and other accessories on the mock-up boiler front.

ASSIGNMENT:

1. Select trainees and have them install a Bailey Feed Water Regulator insomuch as is possible under classroom conditions.
2. Review, and have the trainees answer oral questions.

TIME — 6 to 9 hours.

TOPIC NO. 52

I. Topic — Installing Winches.

II. Tools and Equipment

1. Number 4 corner drilling machine
2. Drills:
   a. 1 full-length
   b. 1 half-length
   c. 1 — 12″ extension
   (The sizes of the drills depend on the holes in the base of the winch)
3. Shipfitter's taper reamer (bolt-hole size)
4. Chalk line
5. Center punch
6. Full set of wrenches
7. 1 — ¾-lb. hammer
8. 6′ tape
9. 50′ tape
10. Pocketknife
11. Portable grinder
12. 8″ outside calipers
13. 8″ inside calipers
14. Thickness gauge
15. 14″ second-cut flat file
16. C-clamps
17. Dividers
18. Oilstone
19. Spoon bearing scraper
20. Hermaphrodites

Supplies

2 round steel bars 18″ long (these bars mu
fit the hole in the winch base easily, b
snugly)
Red lead
Tarred felt
Tacks
Studs
Nuts
Grommets
Washers
Garlock packing
Chalk
Bolts
Piece of 1-1/16″ round stock 6″ long
Mock-up of an anchor winch. See Fig. 27
Mock-up of an afterdeck winch
Mock-up wood foundation for anchor winc
See Fig. 28
Mock-up afterdeck for afterdeck winch
Mock-up foundation channels
Wedges, blocking, drive-fit dowels
Mock-up chain locker
Bell mouths in a mock-up forward deck
Layout fluid

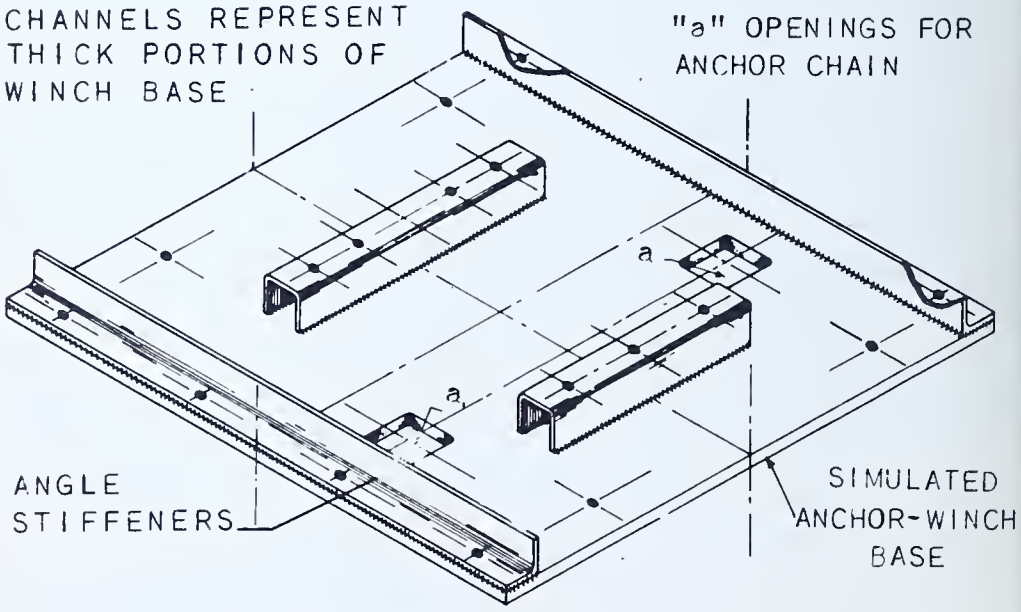


Fig. 27 — *Mock-up Anchor Winch or Windlass*

REFERENCE — *Shipyard Outside Machinist*, page 209.

INSTRUCTIONAL AIDS

A. Blueprints of winch installations.

B. Wall charts showing winch installations in plan and elevation.

TEACHING HINTS:

A. Safety:

1. Avoid warping or binding parts of the mechanism.
2. Never lay an air drilling machine down while it is in motion.
3. Carefully inspect the hole location when drilling through from either above or below deck to avoid damage to conduit or electric cable lines.
4. Particularly stress the care which should be used in handling tools and materials to prevent damage and resulting inaccuracies.

B. Information to be presented:

1. The procedure, beginning on page 209 of the *Shipyard Outside Machinist* manual, for "Installing Winches".
2. The locating points of the winch. (Anchor winch or afterdeck winch)
3. The reason for beginning the layout at some particular point, and at what point the work should begin. (Mention various conditions which govern the layout planning.)

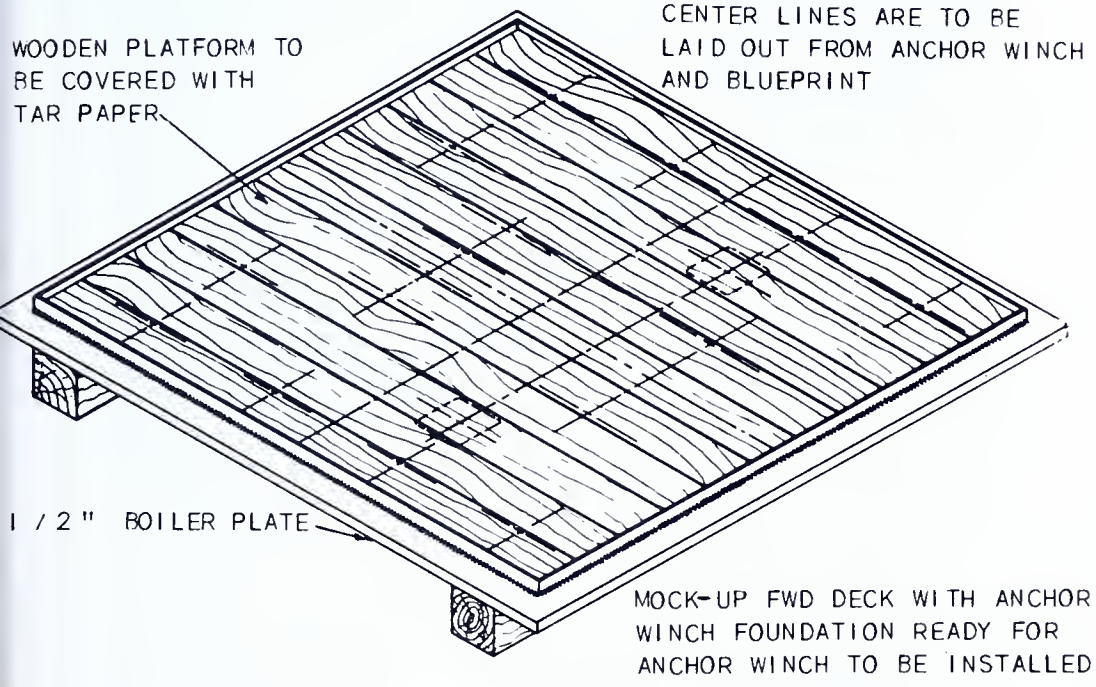

WOODEN PLATFORM TO BE COVERED WITH TAR PAPER
CENTER LINES ARE TO BE LAID OUT FROM ANCHOR WINCH AND BLUEPRINT
1 / 2" BOILER PLATE
MOCK-UP FWD DECK WITH ANCHOR WINCH FOUNDATION READY FOR ANCHOR WINCH TO BE INSTALLED

FIG. 28 — *Mock-up of Wood Foundation*

4. The procedure on page 213 of *Shipyard Outside Machinist* manual.

   Carry the layout through on the blackboard. Call on members of t class to repeat the steps taken as the layout progresses. (Make sure the steps are understood by the class.)

5. The procedure on page 217 of *Shipyard Outside Machinist* manual. (Repeat the sequence in item 4.)

C. Demonstration by the instructor, and Student practice: (Have ready a mock-up of a forward deck and a mock-up of an anch winch.

1. How to lay out, from the blueprint, the location and centers of an anch winch on the forward-deck mock-up. (Have different trainees assist as other trainees watch the procedure. I terrogate the trainees as the work progresses. Proceed slowly enough f the trainees to understand thoroughly and grasp the reasons for t methods used.)

2. How to proceed with the work until the layout is completed and t mock-up winch is installed.

V. Assignment:

The instructor may exercise judgment in the assignment given. Oral questio may be answered by the trainees; specially prepared blueprints may be giv to the trainees. From these blueprints the trainees may be required to make layout on sheet aluminum or galvanized iron. Some objective check must be ma to establish definitely the proficiency of each trainee.

VI. Time — 18 to 21 hours.

TOPIC NO. 53

TOPIC — Installing a Steering Gear and Telemotor for Pilot House Indication.

TOOLS AND EQUIPMENT

1. Machinist's tool kit
2. Special trammels
3. Portable grinder
4. Air drilling machine
5. Acetelyne-welding equipment

SUPPLIES

Mock-up of main steering-gear ram and cylinder foundation. See Fig. 29

Mock-up of main steering-gear rams and cylinders. See Fig. 29

Chocks

Chock sheets

Necessary bolts, nuts, jacking screws, and wedges, or thickness blocks

REFERENCE — *Shipyard Outside Machinist,* page 223

INSTRUCTIONAL AIDS

A. Wall chart of steering-gear units in plan and elevation.

B. Blueprints of steering-gear installation.

TEACHING HINTS:

A. Safety:

1. Never push on a wrench with fingers closed around the handle.
2. Stress the care of tools and equipment and the necessity for adequate lighting when doing an accurate job of this kind.

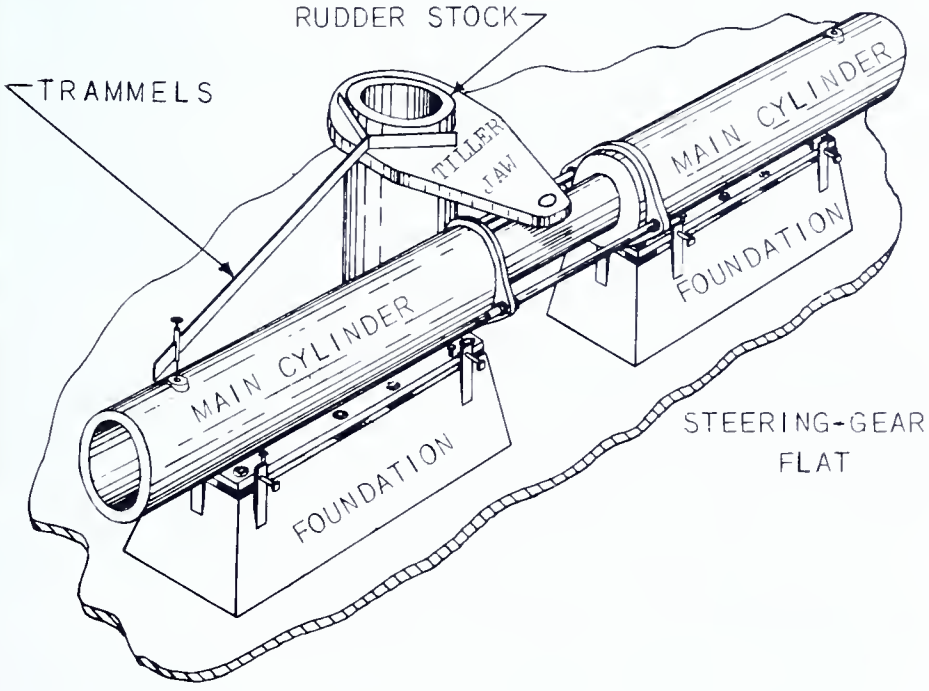


FIG. 29 — *Mock-up Main Steering-gear Rams and Foundations*

B. Information to be presented:

1. The procedure, beginning on page 223 of the *Shipyard Outside Machi ist* manual, for "Installing a Steering Gear".
2. The necessity for aligning the rudderstock first. (Page 224 of the *Shi yard Outside Machinist* manual and Fig. 277, page 226.)
3. The sequence of procedure for the installation of the steering gear the steering-gear room.
4. The alignment of the main rams and cylinders to bring the center lin of these units to a 90° angle with the center line of the rudderstoc (Fig. 277 and the ship center line Fig. 280.)
5. The necessity for having a correctly leveled foundation top and correct fitted chocks to maintain the alignment of the unit when bolted dow
6. The purpose of the pin in the tiller block and main ram.
7. How, by means of jacking screws, the unit is moved about on the fou dation to obtain the correct alignment.
8. The reason for installing the units to bring the center of the tiller j ¼" above the ram center.
9. The relationship between the various units, their purposes, and t sequences in which they are installed.
10. The necessity for careful handling of the various pipes and pipe cc nections when they are being installed.
11. The purpose and operation of the follow-up control.
12. The relationships and purposes of the units shown in Figs. 283, 2 300, and 301, *Shipyard Outside Machinist.*

The instructor will find it necessary to use considerable ingenuity a good judgment in presenting this material to the class in order that t trainees may thoroughly understand progressive steps necessary for c rect installation.

C. Demonstration by the instructor, and Student practice:
(Have ready a mock-up steering-gear and ram-cylinder foundation.)

1. How to lay off, from the blueprint, center lines and bolt-hole cent for the ram units. (With the assistance of trainees)
2. How to scribe the bolt-hole centers. (With the assistance of trainees)
3. How to drill the bolt hole. (With the assistance of trainees)
4. How to level off with the portable grinder the surfaces where the choc are to fit. (Have a group of trainees level off the surfaces where choc are to fit.)

5. How to place a mock-up of the main steering-gear ram and cylinder on the foundation. (Have welded in place the pads of the jacking screws shown in Fig. 288, page 236 of the manual.)

6. How to insert jacking screws preparatory to bringing the ram-unit mock-up into alignment. See Fig. 29. (Have a group of trainees insert jacking screws preparatory to bringing the ram-unit mock-up into alignment.)

7. How to align and level the main cylinder and ram mock-up.

8. How to level the unit on the foundation. (Have the trainees assist in measuring for the chock sizes.

   Send the chocks and the chock sheets to the machine shop. Have the trainees fit the chocks according to the procedure in step 22 on page 231, *Shipyard Outside Machinist* manual.

9. How to drill the holes through the chocks and the foundation.

10. How to install the fitted bolts on the corner as instructed in step 29, page 237 of the manual.

11. How to check the job carefully for accuracy and, if correct, pull the bolts down tightly and re-check for alignment.

    During the preceding operations, check frequently to make sure the pin connecting the tiller jaws to the main ram fits freely.

ASSIGNMENT:

1. Have the trainees answer oral questions regarding the installation procedure.
2. Administer subjective, or true-false, tests on sequences of the installation procedure.

TIME — 24 to 27 hours.

TOPIC NO. 54

I TOPIC — Installing a Propeller and Tail Shaft.

II. TOOLS AND EQUIPMENT

1. Outside machinist's tool kit
2. Chain hoist
3. 30-lb. sledge
4. Special spanner wrench
5. Air drilling machine
6. Twist drills

SUPPLIES

Mock-up propeller
Mock-up tail shaft
Mock-up stern frame and shaft alley. Fig. 30
Mock-up scaffold
Mock-up fairwater
Necessary bolts, nuts, and washers
Red lead
Chalk

III. REFERENCE — *Shipyard Outside Machinist*, page 246.

INSTRUCTIONAL AIDS

A. Wall chart of propeller and tail shaft installed (local source).
B. Photographs of the installation procedure.
C. Blueprint of propeller and tail-shaft installation.

IV. TEACHING HINTS:

A. Safety:
   1. Make sure that all tack welding of braces, strongbacks, and supports is secure to avoid injuries caused by falling equipment.
   2. Particularly stress the care which should be used in handling tools and materials to prevent damage and resulting inaccuracies.

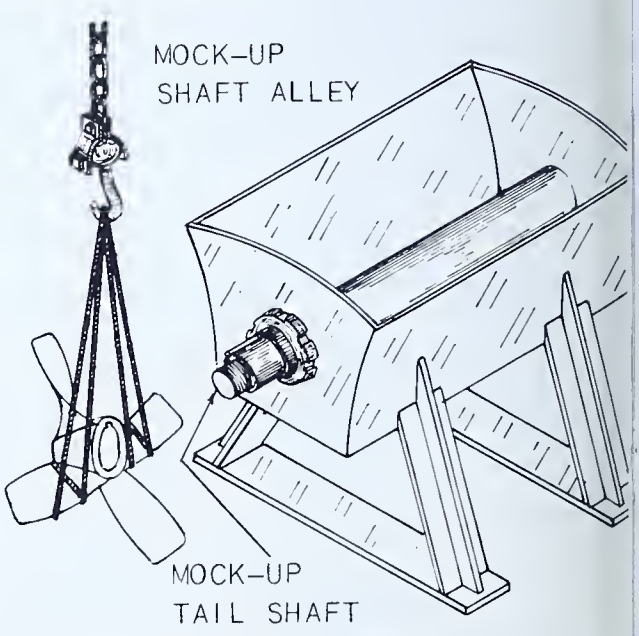


FIG. 30 — *Mock-up Stern Frame and Shaft Alley.*

B. Information to be presented:
   1. The procedure, beginning on page 246 of the *Shipyard Outside Machin* manual, for "Installing a Propeller and Tail Shaft".
   2. The position of the drilled holes for holding the fairwater in place the stern-frame eye.
   3. The reason for drilling and tapping the hole after the lock nut is install to receive the locking device in the stern-frame-eye wall.

4. The necessity for having the tail shaft in the hole in the propeller "fair". (Prevents damaging the fitted surfaces.)

C. Demonstration by the instructor, and Student practice:
(Have ready the mock-up stern frame and shaft alley.)

1. How to install the tail shaft in accordance with the instructions on page 249 of the manual. (With the assistance of trainees)
2. How to remove the tail shaft and repeat (the work being done by the trainees only) under the supervision of the instructor.
3. How to prepare to raise and place the propeller mock-up on the tail shaft.
4. How to adjust a cable sling correctly to the mock-up propeller and hook on with the chain hoist.
5. How to raise the mock-up propeller preparatory to installing it on the tail shaft.

   Have the trainees install the propeller under the supervision of the instructor.
6. How to place the lock nut, insert a turn of red lead, and turn the lock nut home.

   Operations in steps 6, 7, 8, and 9, on page 249 of the *Shipyard Outside Machinist* manual, should be carefully observed.
7. How the lock nut is secured by the locking device in position as shown in Fig. 308 in the manual.

   Have the trainees locate and drill a hole to receive pin "a", Fig. 308.
8. With locking device (shown in Fig. 309 of the manual) have the trainees mark centers and drill and tap holes in the lock nut to hold the locking device.
9. Have the trainees install the fairwater under the supervision of the instructor.

   (Fairwater bolt-head openings may be cemented.)

ASSIGNMENT:
(Strip the stern-frame and shaft-alley mock-up to its original condition, and make ready for the trainees to install on their own initiative a propeller and tail shaft.)

1. Review the work of installing a propeller and tail shaft.
2. The trainees will be given an opportunity to ask questions.
3. Call for four volunteer trainees (or more if necessary) to install the mock-up propeller and tail shaft. The instructor will give no assistance other than to stop the progress of the work if the trainees are in error.
4. Repeat this procedure until the entire group has had an opportunity to become acquainted with the necessary procedure.

TIME — 3 to 6 hours.

TOPIC NO. 55

I. Topic — Launching a Tanker.

II. Tools and Equipment

None

Supplies

Model of a ship hull on the ways ready for launchi with the rudder stop installed

Chain hoists attached to the tiller jaws shown in F 314 of the *Shipyard Outside Machinist* manual

A locking device to keep the line shaft from turni shown in Fig. 316, of the manual

III. Reference — *Shipyard Outside Machinist,* page 251.

Instructional Aid

Model of a ship hull on the ways ready for launching.

IV. Teaching Hints:

A. Safety:

1. Stay clear of the ship's hull and launching equipment to avoid inju while the ship slides down the ways.
2. Stress particularly the danger resulting from tampering with any mat ials or devices without authority.

B. Information to be presented:

1. The procedure, beginning on page 250 of the *Shipyard Outside Machin* manual, for "Launching a Tanker".
2. The sequence of procedure in which the launching of a tanker concer the outside machinist.
3. The several procedures in the installation of chain hoists, struts, and oth devices for securing the rudder and tail shaft while the ship is bei launched.

Question the trainees to make sure the information presented has be thoroughly understood.

V. Assignment:

1. Have the trainees answer the questions on page 253 of the *Shipyard Outs Machinist* manual.

VI. Time — 9 to 12 hours.